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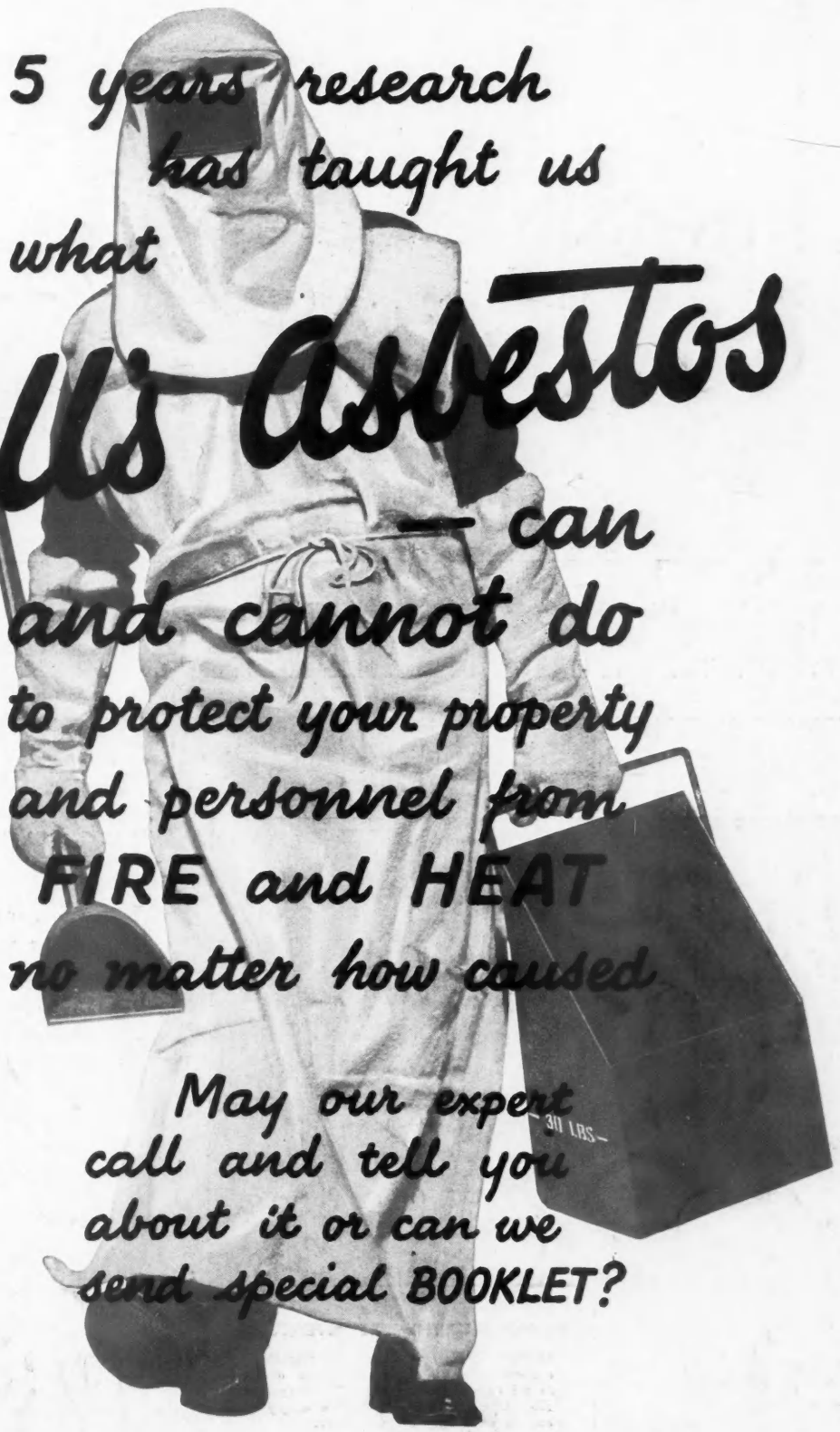

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British Naval Casualties

ON Friday, December 8th, it was officially announced by the Secretary of the Admiralty, that the destroyer H.M.S. "Jersey" was damaged by a torpedo fired from a German submarine on Thursday, December 7th. The ship is now in harbour. Two officers and eight ratings are reported missing and are believed to have been killed, while two officers and ten further ratings are injured. The "Jersey" is one of two destroyers of the "Javelin" class, built and engined by John Samuel White and Co., Ltd., of East Cowes. The "Jersey" was one of seven destroyers ordered in the 1936 programme, and she was begun at the end of September, 1937, launched about a year later, and commissioned during the present year. She has a displacement of 1690 tons and carries a complement of 183 officers and ratings. Her length is 348ft. with a beam of 35ft. and a depth of 9ft., and she is equipped with Parsons geared turbines having a designed output of 40,000 S.H.P. corresponding to a speed of 36 knots. Steam is taken from two Admiralty three-drum type boilers. The armament comprises six 4·7in. guns, six smaller guns, and ten 21in. torpedo tubes. It is also announced that the destroyer, which sank after striking a mine on Tuesday, November 14th, was H.M.S. "Blanche." This vessel was completed by R. and W. Hawthorne Leslie and Co., Ltd., in 1931, and she was of the "Beagle" class, ordered in the 1928 programme. Her displacement was 1360 tons with dimensions 323ft. overall, breadth 32ft. 3in., and mean depth 8ft. 6in. Her Parsons geared turbines had a designed output of 34,000 S.H.P. corresponding to a speed of 35 knots, and two Admiralty pattern three-drum boilers were fitted. This class of destroyer was most successful and all the ships exceeded their designed speed with ease. The armament comprised four 4·7in. guns, seven smaller guns, and eight 21in. torpedo tubes on quadruple mounts, these being the first destroyers with torpedo tubes quadruply mounted. A further loss, announced by the Secretary of the Admiralty on Monday, December 11th, was the drifter "Ray of Hope" which was sunk by a mine on Sunday afternoon. We regret to have to record that four of her crew were killed and five are missing.

Aerodromes in Canada

BY arrangement between the Ministers of National Defence and Transport in Canada, the Air Services Branch, Department of Transport, is charged with the selection, survey, and construction of all airports which may be required for the Empire air service training programme. Reconnaissance and survey parties are now in the field in the maritime provinces, Quebec, Ontario, Manitoba, Saskatchewan, and Alberta. It has been necessary to increase the field staff, and advantage has been taken of a timely offer of the Government of Ontario to place at the disposal of the Dominion Government a number of aircraft and experienced pilots for work in the emergency. Two aircraft and eight pilots are now on loan from the provincial air service of Ontario, and are working with these reconnaissance and survey parties placed in the field by the civil aviation division and on transportation duty. Further valuable assistance has been rendered by the Government of Ontario in this work in Ontario, by making available from the provincial Department of Highways experienced land survey parties which are making the detailed contour surveys required of any new aerodrome sites after they are selected by the Department of Transport Officers and approved by representatives of the R.C.A.F. It is hoped to complete the airport selection and survey programme before severe weather sets in. This will enable detailed plans and specifications to be prepared during the winter so that the necessary grading, drainage, and surfacing work on the new aerodromes now in use may be rushed as soon as weather permits next spring. The selection of sites this year will also enable buildings to be erected for the housing of men, hangers for the aircraft, workshops for their maintenance, and other necessary facilities to be installed with the least possible delay. Much of this work can proceed during the winter months.

Export Trade

ON Thursday, December 7th, the export trade of this country was discussed in the House of Commons. Mr. Oliver Stanley, President of the Board of Trade, said that in the first month of the war there had been a very heavy fall amounting to about 38 per cent. in the value of our exports. That was not unexpected owing to the general dislocation of trade and the imposition of restrictions which had to be administered by machinery that was inexperienced and overloaded. A comparison between September and October showed a small rise from £23·1 millions to £24·6 millions. Although the final figures for November were not yet ready for publication, preliminary figures showed that the rise, in comparison with October, was in the neighbourhood of 50 per cent., so that the level was now about back to that of the last month before the war began, although still below that of November, 1938. Comparing the position with 1914, he observed that there was a fall of 46 per cent. in the first month of that war and that it was not until 1916 that the value of our exports got as close to the figures in the comparable month in the last year of peace time as they were in November of this year. Referring to the licensing system, he remarked that steps were being taken to make its operation as easy as possible. It was only to about 30 per cent. of our pre-war exports to non-enemy countries that licensing applied. For a large range of export trade to-day markets were not the real difficulty. Inquiries were not merely up to peace time level, but were increasing. The difficulty was more likely to be that of supply; a matter that depended on capacity, raw materials, and the desire on the part of the exporter to take advantage of the opportunities offered. His remark that he would not admit that every Service requirement must have priority over every civilian requirement was greeted with approval. Towards the end of his speech he said that the Government fully recognised the importance of the type of exports where the risks were not purely economic, and he believed that they had in the various Departments all the powers necessary to make bargains with any of the countries they had in mind. The real problem was to see that those powers were collated. A sub-committee of the Economic Policy Committee had been set up charged with this function alone.

Railway Wages

LAST week the three railway trade unions, the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Railway Clerks' Association, were notified by the railway companies of the acceptance of the unanimous findings of the Railway Staff National Tribunal on the wage claims that were recently put forward. By these findings the minimum rate for drivers and motormen is to be raised to 13s. from 12s. per day, and certain improvements in Sunday duty pay and night duty pay of the salaried staff are also provided for. The railway companies have also accepted other findings of the Tribunal which were not unanimous. They have accepted the majority finding on the claim for a 50s. minimum wage. It awards a 50s. minimum wage in London for men and 38s. for women; 48s. minimum in industrial areas for men, and 36s. 6d. for women; and 47s. minimum in rural areas for men, and 35s. for women. This finding was the more favourable to the men's claims as the minority proposed lower minimums. These higher rates of pay, as recommended by the Tribunal, are to be retrospective in application to the first full pay period after October 28th. It is estimated that the direct cost of the concessions will be £660,000 a year, and that adjustments of other wage rates to make them accord with those affected by the agreement will cost another £350,000, making a total of rather more than £1,000,000 per year. A meeting between the companies' representatives and the unions to consider these consequential adjustments was held yesterday.

Loss of the "Thetis"

THE inquiry into the sinking of the submarine "Thetis" in Liverpool bay on June 1st, was reopened at the Law Courts on December 11th. It is being held, it will be recalled, by Mr. Justice Bucknill, assisted by three assessors, Capt. Menzies, a naval submarine expert, Capt. Riley, one of the Elder Brethren of Trinity House, and Professor T. B. Abell, Professor of Naval Architecture at the University of Liverpool. At previous sessions of the inquiry, held soon after the disaster, it was revealed that the two forward compartments of the submarine were flooded through a torpedo tube, the bow cap of which was, for some undetermined reason, open. The inquiry was subsequently adjourned until such time as the submarine should have been raised and its condition could be examined. One of the puzzling features of the disaster is that so few escapes were made with Davis apparatus. At the resumed inquiry Commander R. L. M. Edwards, submarine assistant to the Director of Naval Equipment, gave it as his opinion that the bow cap of the torpedo tube was not open when the submarine left Liverpool. It could not be opened unless power was applied through a tele-motor system. In his view some ten minutes before the accident and after power had been put on, someone had inadvertently moved the operating lever towards the open position. Then perhaps realising he had moved it, but not realising what difference it made, he replaced it. It might have been someone with no technical knowledge of the levers and owing to the restricted room in the compartment might quite easily have been done. It was found, when the submarine was raised, that one of the doors of the escape chamber was open and also one of the flooding valves, with the result that water had flooded the engine room. In reference to that matter Commander Edwards said that it would have been possible to use the whole engine room itself as an escape chamber, but that if those in the submarine had wished to so use it they would have chosen a quicker and readier method of flooding it than a two-inch pipe. It was also pointed out by another witness that if that had been the intention all the men would have been wearing escape apparatus whereas in fact only about 50 were. The same witness made the suggestion that a man using the escape chamber had fallen into a panic as the pressure rose and that in the endeavour to get him out the door of the chamber was opened and the engine room thus flooded. When the inquiry was continued on Tuesday little additional information became available. Mr. L. C. Williamson, Assistant Director of Naval Construction, said that on November 23rd experiments were carried out and showed that with the bow cap operating lever in the position in which it was found no motion took place when power was applied. He could think of no explanation as to how the lever came to be moved, and supported Commander Edwards' view that the bow cap was shut when the vessel sailed. Commander Edwards said that he had been through the logs notebooks and documents found in the submarine, but had discovered nothing in the control room log which seemed to refer to the day of the disaster. Proceedings were then adjourned by Mr. Justice Bucknill, who said that to his mind the most difficult point in the case was the opening of the bow cap. On Wednesday speeches were made by the Counsel representing various interests.

Taxes and Advertising

THE Board of Inland Revenue has just made a constructive ruling which unquestionably will be of very considerable value to British industry, particularly to firms that have built up an export trade, including those marketing equipment to the international oil industry. The Board will not seek to contest the deduction of reasonable advertising expenditure from trading profits arising from both Government and commercial manufacturing contracts before computing the amount of income and excess profit taxes in the cases of manufacturers, engineering companies, shipbuilders, &c., who have wholly or partly devoted their facilities to Government contracts—provided it is their intention to revert their factories to industrial manufacturing at the completion of Government contracts. This is of the greatest importance, because on Government contracts, subject to technical costing by Government accountants, advertising expenditure and trade subscriptions are not permissible in arriving at overhead expenses. The new ruling should do much to provide publicity funds which can be used to help secure such engineering and equipment business overseas that hitherto has been in the hands of German industry. An excellent opportunity now awaits those manufacturers who can turn their sales attention to these export markets.

The F.B.I. and Export Trade

ON Monday last the Prime Minister, the Chancellor of the Exchequer, and the President of the Board of Trade received a deputation from the Federation of British Industries. The deputation which was introduced by Lord Dudley Gordon, deputy president of the Federation, emphasised the importance of export trade. It suggested that it should not merely be regarded as an ancillary activity. There were many conflicting claims on the productive capacity of the country for the Service departments and other needs, but it was suggested steps should be taken to secure a unified policy which would give its due place to the needs of the export trade. There would be an advantage in establishing a single authority charged with the oversight of the export trade, and under the control of a member of the War Cabinet acting with the advice of a panel of industrialists. In reply the deputation was given an account of existing machinery for the determination of priorities and an explanation of existing Ministerial and Inter-Departmental arrangements for the co-ordination of economic policy. The Prime Minister said that in the circumstances he did not think that there would at the present time be advantage in appointing a separate Minister for economic questions. Under the changing conditions of war, however, no such decisions could be regarded as fixed and final. An agreement was reached that the President of the Board of Trade should communicate at once with the Federation in order to discuss the possibility of improving the existing machinery by the appointment of an advisory panel.

H

Modern Railway Signalling Practice

No. II

(*Continued from page 566, Dec. 8th*)

THE application of power to the control and operation of semaphore signals and points was quite a simple matter when first carried out in this country some forty years ago. A motor was installed on the signal mast, or in the 6-ft. way, to do the work that the signalman had previously to do himself, through the agency of a lever with a big mechanical advantage and a length of rodding or wire. Power working, by reducing the amount of physical effort required from the man to a negligible quantity, enabled more signals and points to be worked by one operator; a degree of centralisation could be effected since it was possible to operate the various functions from greater distances than hitherto, and the ease of manipulation of the miniature levers made for smarter working generally at busy periods. But these earlier installations of power signalling incorporated no additional safeguards, either from the traffic point of view or to counteract possible signalmen's errors; lock bars were still needed for the protection of facing points, and separate motors were put in to operate them. The only interlocking was the purely mechanical mechanism between the levers in the locking frame—a reproduction on a smaller scale of the familiar apparatus for manual signalling. Fig. 14 on page 592 shows a typical instance, the apparatus at Paragon station, Hull, installed in 1904 and not replaced until 1938.

It is a far cry from these pioneer interlockings to the highly developed control machines of to-day, but a brief account of the more important intermediate steps forms a useful introduction, and may, it is hoped, assist in a readier appreciation of the significance of modern signalling tendencies in Great Britain. There is no need to describe the mechanical details of the machines used for signal and point operation, still less to enter into the controversy that has raged from the earliest power-signalling days on the merits of all-electric *versus* electro-pneumatic working; this article is concerned with the art of control in its broadest sense, and from that point of view it matters not whether the points are shifted by an electric motor or a pneumatic cylinder.

The development of track circuiting enabled a definite interlock to be introduced between the locking frame and trains passing through the area controlled. Hitherto the only safeguard of this kind had been through the agency of the mechanical locking bar, the effectiveness of which was restricted to a distance of some 50ft. in advance of the facing points. By track circuiting the portion of permanent way including the points an electric lock can be applied to the miniature lever operating the point machine; the lock bar can be dispensed with, and a greater degree of safety introduced, since the track circuit can be extended to any distance desired on either side of the actual points. In addition, track circuit locking is not confined to the point operating levers. It can be applied to signal levers for providing other safeguards in traffic working. An example of such safeguards is to be found in the locking of a signal lever in its normal or "danger" position when the track circuit on to which the signal in question leads is occupied by a train.

It will now be appreciated that on the modern control frame there are two distinct varieties of interlocking. The first is the locking between the various levers, which prevents a signalman setting up any conflicting routes or initiating any movement that could result in a collision; the second is the locking between the levers and the traffic, which may be termed a safeguard against errors of judgment on the part of the signalman. For a long time the lever interlocking remained a purely mechanical mechanism, while the track locking could not be done otherwise than by electro-magnets. In this latter category, too, must be included the indication or check locking used on many of the levers to prove that the operating mechanism at the points or the colour-light signal has responded correctly to the pulling of the lever.

The realisation that the use of power signalling made possible considerable economies and greater efficiency led to the installation of some very large and comparatively complicated plants in the period 1924–1928. Increasingly severe traffic requirements demanded a vast amount of lever interlocking, and some highly intricate mechanisms were the result. Furthermore, a few years of experience in the operation of intense electric services suggested various modifications to the signalling lay-out, each of which required corresponding alterations in the interlocking, both between levers and otherwise. Such alterations proved very costly, both in time spent in redesigning the mechanisms and in carrying out the change-over work under traffic conditions. It was at the same time realised that similar changes might from time to time become necessary in any layout, from causes quite unconnected with the signalling itself; a specific instance that comes to mind is that of changes rendered necessary by the lengthening of platforms at an important terminus consequent upon a big train service revision.

These considerations led up to the building in 1928 of the first all-electric locking frame. To supersede the mechanical interlocking mechanism —for so long deemed a *sine qua non* of any signalling system—by a scheme of purely electric interlocking was at the time considered quite a revolutionary step. In the new frame the pulling of a miniature lever caused a vertical contact shaft to revolve, and the consequent making and breaking of contacts was linked up with the operation of a special set of electro-magnets set aside for lever interlocking. Several advantages were immediately apparent. Alterations to the interlocking involved nothing more than a few changes in

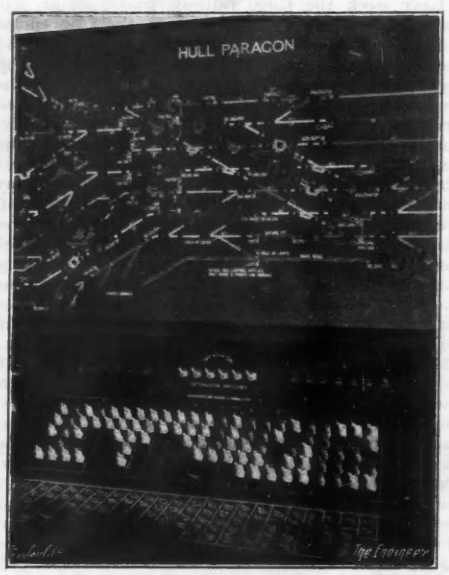


FIG. 10—PART OF NEW CONTROL PANEL, HULL

wiring, and the exchanging of the requisite number of contact bands on the lever shafts; the alignment of the frame which, to ensure that a large mechanical mechanism should work freely, needed to be really accurate, was no longer of vital importance; lastly, where space was limited the frame could be built in two or more sections, since mechanical connection between levers was no longer necessary.

Once the natural reluctance to part with the well-established mechanical interlocking mechanism was overcome further striking developments came rapidly. Before considering these, however, it is necessary to refer to the second essential component of modern signal-box equipment, the illuminated track diagram. This appliance was devised primarily for use in locations such as are to be found on the London tube railways, where signal-boxes are hollowed out in the very bowels of the earth and the signalmen never see any of the trains they are controlling. Under modern conditions the attributes of the illuminated diagram have been used in the preparation of remote control schemes on surface lines. With such provision there is no need for every traffic movement to be seen from the signal-box, and the area controlled from one point can be extended as far as desired. Fig. 15, which illustrates the illuminated diagram and part of the all-electric locking frame at St. Enoch station, Glasgow, L.M.S. Rly., gives some impression of the size of lay-out that can be efficiently operated from one modern control machine. Here, for example, the points and signals at Gorbals Junction are over a mile away, on the opposite bank of the river Clyde, and well out of sight of the signal-box.

Many advantages are to be derived from the concentration of control in a large and complicated area at one central point. Traffic officers can more readily visualise train movements as a whole, and supervise or improvise as conditions may demand. Theoretically there is now no restriction upon the size of layout controlled from one signal-box, but practical considerations impose a very definite limit. In the case of extensive plants remotely controlled the cost of cable may well prove prohibitive, while there is a general feeling nowadays that it is unwise to put all the signalling "eggs" into one basket. At the present time one thinks instinctively in terms of A.R.P., and for that reason alone too much in the way of concentration is not desirable; but even in normal times exceptional conditions, such as a local outbreak of fire, may render the power-signalling system inoperative for a while, and then the smaller the plant, the less the dislocation of traffic that results.

It would, however, be a confession of weakness were the fear of hold-ups, due either to mischance or to air raid damage, seriously to retard the steady progress maintained in the art of signalling. Instead one finds the greatest care taken to protect the whole system from the danger of fire, and signal-boxes rendered as near as possible bomb-proof, save from the thousand to one chance of a direct hit. At the time of writing, indeed, several noteworthy schemes prepared in peace time are, under the stress of war conditions, being brought to fulfilment. In certain of these opportunities of revision have occurred, but there has seemed little desire to do much in the way of de-centralisation, even when the imminence of war gave a strategic bias to any railway project.

Continuing now the discussion of the subject of control purely from the scientific point of view, it was not a big step from the abolishing of the traditional form of lever interlocking to abolishing the lever itself. This development came in a somewhat indirect way. The problem of centralising control on long stretches of single line, and regulation of traffic at the passing loops, led to the invention, in America, of the coding system of point and signal control, referred to usually as "C.T.C."—Centralised Traffic Control. Up to the present there has been only one instance of C.T.C., as such, in this country, but its principal interest in connection with the present subject is that the necessary interlocking between signals and points is done not by a direct lock on the levers concerned but in the control circuits by relays. Thumb-switches replace the miniature levers of the orthodox power locking frame, and these switches are free to be turned at any time; if the signalman should make a mistake and try to operate any function under dangerous circumstances, that function just does not respond to the movement of the controlling thumb-switch. Such is the essential feature of the modern control-panel machines which are now coming into favour on certain lines in this country. The illuminated track diagram is incorporated in the control unit, and the thumb-switches are often arranged on the diagram itself, as near as practicable to the correct geographical position of the pair of points or signal concerned.

In order to simplify the manipulation of these panel machines most of those now being installed are arranged for route switching rather than for separate working of individual points and signals. The panel machine at Paragon station, Hull, L.N.E.R., illustrated in Fig. 16, which has superseded the locking frame shown in Fig. 14, controls 230 routes. Each of these routes is associated with one or other of the signals, and since there may be as many as twenty routes leading from one signal location it is not practicable to arrange the operating thumb-switches on the illuminated diagram. In Fig. 10, a close-up view of part of the machine; the grouping of the switches on a sloping keyboard below the track diagram is shown. The extent of the "routes" set up is usually from one signal to the next, but as the path of the train may, in a busy yard, lead over a number of points and crossings a large amount of individual switching is avoided. As in the separate working of points and signals, if any part of the route that an operator is attempting to set up conflicts with a movement already in progress or authorised the apparatus concerned does not respond and the signal fails to clear.

Fig. 11 shows a typical case of route setting where, to show the signalman that all the various units have correctly lined up, a series of white lights is illuminated. This is a comparatively short " route " in a main line junction ; more complicated settings, including six or more pairs of points, are to be found in the approaches to large terminal stations, and in these the saving of time in switching is very considerable. Ordinarily

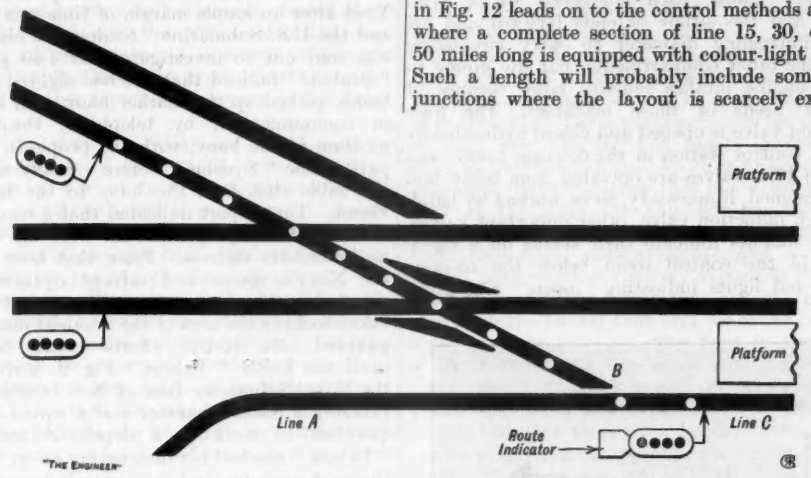


FIG. 11—EXAMPLE OF ROUTE SWITCHING

every function in such a route is held locked until the train has passed through the whole length and all the track circuits concerned are clear again, but in the case of long complicated routes in a busy yard this holding of the route, to the bitter end so to speak, might cause delay at times when a lot of shunting has to be done. To obviate this a process termed sectional release route locking is introduced. As the name suggests, the holding of the route is released in sections ; thus when the tail of the train has cleared the fouling distance of points B—referring again to Fig. 11—those points are free to be moved, to allow, say, a train to be backed into platform line C from the line designated A. Similar releases take place as the train first signalled clears each section of the route, and this facility gives a much increased flexibility in working.

So far the matter of control has been considered in relation to one station only, where it is convenient to bring all train movements—freight, passenger, and shunting—under the jurisdiction of one signal-box. Such extreme centralisation would not, however, give the best results in many localities, for improved operation of through traffic might be obtained only at the expense of increased difficulty in carrying on local movements at locations out of sight of the signal-box. Fig. 12 illustrates the track arrangement in a typical lay-out of this kind. In the neighbourhood of " X " on the diagram a good deal of shunting takes place ; freight trains are remarshalled to a limited extent, some through services change locomotives, and a number of movements across the main line are involved. From the point of view of express passenger traffic it is desirable that the main signal-box at " Y," adjacent to the passenger station, should be able to claim priority in the use of the through lines at locality " X." On the other hand, the box at " Y " is not directly interested in

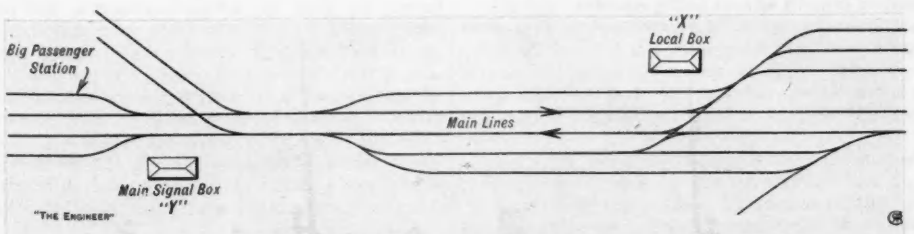


FIG. 12—CONJUNCTION OF THROUGH AND LOCAL TRAFFIC

local movements at " X," which can be conducted far more efficiently by a signalman on the spot.

An interesting solution of this problem is obtained by giving the box at " Y " absolute control of all points on the through lines, but installing a subsidiary box at " X " to deal with purely local movements. Box " X " takes no part in the signalling of through trains, and when the man there has a movement to signal across the main lines the box at " Y " must be requested to operate the points required. Box " Y," retaining the master control, is in a position to judge whether such a cross-over move is likely to delay a more important train. The setting up of a local signal-box at a locality such as " X " is more economical in first cost too. Purely mechanical apparatus, with semaphore signals, is usually quite adequate, although the electrical connections with the main power box require electric locks on certain key levers in the local locking frame.

Consideration of a layout such as that shown in Fig. 12 leads on to the control methods adopted where a complete section of line 15, 30, or even 50 miles long is equipped with colour-light signals. Such a length will probably include some small junctions where the layout is scarcely extensive enough to justify a complete power interlocking with motor worked points. In some such instances a full-sized mechanical locking frame is used, working the points by rodding and the colour-light signals by electric circuit controllers driven off the lever tails. A neater arrangement is that illustrated in Fig. 17 where the signals are operated by thumb-switches on the illuminated track diagram, as in a complete panel machine, and the only full-sized levers are those needed for working the points. The method of interlocking between points and signals is very interesting. It is obviously impracticable to arrange any satisfactory mechanical interlock between the little thumb-switches and the powerful point levers, and so it is done electrically ; a positive lock is applied to the lever tails, preventing them from being pulled if conditions are not correct, and relay interlocking is used in the signal control. In the latter case the thumb-switches on the diagram can always be turned, but through the agency of the various interlocking relays in the control circuit the signal is cleared only when conditions are safe.

The success with which traffic is controlled in such an area depends to a large extent on the communication between boxes and the amount of advance information that can be given to a signalman as to the train approaching. Quite apart from its value as an integral part of the control machine in the signal-box the illuminated track diagram can be of immense help. Fig. 13 illustrates an imaginary stretch of main line, about 20 miles long, which is at the same time quite typical of layouts found in this country. At each end there is an important junction, and intermediately there is a minor junction ; only three signal-boxes are needed at the points marked P, Q, and R. Between P and Q there is a stretch of plain double-line track, some 12 miles long, with no points or crossings and over it the signalling is purely automatic ; the indications displayed by the colour-light signals vary according to the occupancy of the track circuits forming the block sections, as described and illustrated in the first article of this series. Between Q and R there is a similar, though rather shorter, stretch of automatic signals.

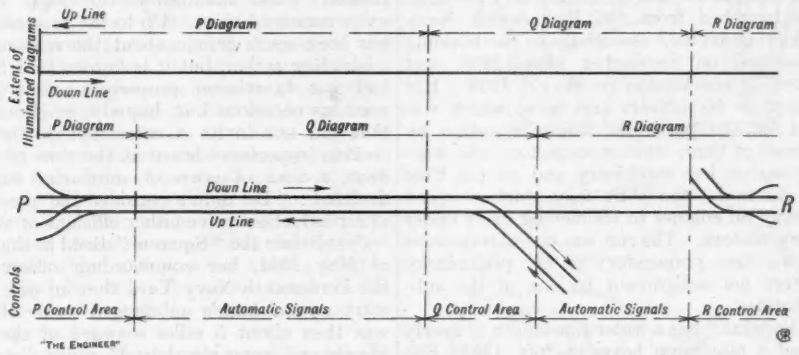


FIG. 13—EXTENT OF ILLUMINATED DIAGRAMS

Fig. 13 also shows the area displayed on the illuminated diagrams in each of the boxes P, Q, and R. From this it will be seen that a train travelling from R to P appears on Q diagram immediately it leaves the area directly controlled by R. Its progress can be watched on Q diagram all the time it is running through the lengthy automatic section. The signalman at Q knows its exact whereabouts and can arrange any local movements in his own small control area with the certainty that the important through train that is approaching will not be delayed. This advance information of the nearness or otherwise, of on-coming trains is of even greater value at a big junction such as P or R. With all trains running punctually each slips into its allotted path in the time table ; it is when things get out of order that improvising has to be done, and then a series of extensive illuminated diagrams, such as those depicted in Fig. 13, are of the utmost value to signalmen and traffic controllers in so ordering train movements as to get back to normal at the earliest possible moment.

Purely power systems such as have been considered in this article form only a part of the control methods used in modern British signalling practice, but in concluding the discussion of this side of the subject the present position may be briefly summarised. The all-electric interlocking frame and the route-switching control panel machine are developing each along its own lines. For compactness the control panel is second to none, but on the other hand the locking frame proper, being built up on the unit principle from a number of standard parts, lends itself more readily to extensions or alterations. In these days when strategic values cannot be left out of consideration the adaptability of the conventional type of locking frame is a big point. In any case, however, it would be very difficult to lay down definitely what is the ideal form of power signal control, as conditions in different layouts vary so enormously. For a large main-line junction, where through and local traffics in about equal proportions are handled, it may well be that a combination of panel and locking frame control could be used to the greatest advantage ; a central control panel with a bird's-eye view, so to speak, of the whole layout and its approaches for many miles in all directions, and two or more individual signal-boxes, each situated at the actual junction of important routes. The central panel would have master control over all through movements, while actual operating would be carried on by the local boxes. That, however, is attempting to take a look into the future.

(To be continued)

WORLD ELECTRICITY PRODUCTION.—A report of the Electrical Industries Bank of Zurich estimates the world production of electricity last year at 460,000 million kWh as compared with 280,000 million kWh in 1929.

Salvage of U.S. Submarine "Squalus"

No. I

THE U.S. Submarine "Squalus," at the very beginning of a submerged training run, sank to the sea bottom off the coast of New Hampshire about 8.40 a.m. (daylight saving time) on May 23rd of this year. She had aboard of her at the time 59 people; and 33 of that number were recovered, from a depth of 240ft., the next day with the aid of one of the rescue chambers with which certain of the U.S. Navy's submarine bases are equipped. The "Squalus" subsequently was brought up to the surface with pontoons in three lifts and towed to the U.S. Navy Yard, Portsmouth, N.H., 113 days after the vessel sank because of the failure of the high induction valve to close just before the submarine dived.

The "Squalus," see Fig. 1, is one of a numerous group of identical boats, and before her fatal mishap she was generally believed to typify a substantial advance in safety measures in her operating equipment, and in her military features. She was launched from the Portsmouth Navy Yard, which is devoted essentially to the building of submarines, on September 14th, 1938, and was placed in commission in March, 1939. Her complement is 56, officers and men, which was amplified for the particular run in question by the presence of three civilian inspectors who were checking up on her machinery and on the time required to make the shift from surface speed under heavy oil engines to submerged drive under her electric motors. The run was one of numerous shake-down runs preparatory to her preliminary tests before her assignment to one of the submarine flotillas.

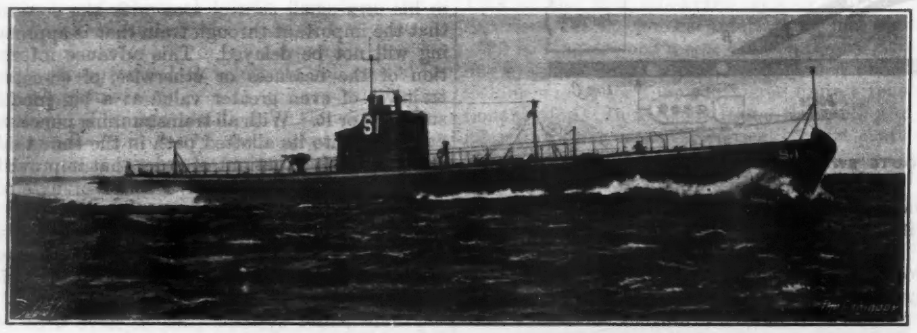


FIG. 1—U.S. SUBMARINE "SALMON," SISTER SHIP TO THE "SQUALUS"

The "Squalus" has a water-line length of nearly 300ft. and a maximum beam of 26ft. 11in. She has a mean draught of 13ft. 8in.; a surface displacement of 1450 tons; and a submerged displacement of 2200 tons. The submarines of her class are said to be able to make the transition from surface speed under engines to full submergence under electric motors in about 60 seconds. The vessel is driven by four 8-cylinder heavy oil engines—two engines abreast in each of the two engine rooms, with two engines on each of the propeller shafts. It is reported that the boats of the "Squalus" class are capable of a speed of 20 knots on the surface. The vessel has four torpedo tubes at the bow and four tubes at the stern from which 21in. torpedoes can be discharged. On her deck abaft the conning tower she carries a 3in. rapid-fire gun on a "wet mount." The pressure-resisting hull is subdivided into eight watertight compartments, with intercommunicating doorways; and the pressure hull is designed to withstand a submergence in excess of 300ft.

The "Squalus" is fitted with an escape hatch leading from the forward and after torpedo rooms, and the conning tower is designed to function as a means of exit when the boat is on the bottom. Momsen "lungs" are carried for all members of the personnel; and at numerous points there are bottles of oxygen for charging the lungs preparatory to essaying escape by any of the outlets mentioned. No attempt was made to use the lungs, although they were issued after the boat sank; the commanding officer, Lieutenant Oliver F. Naquin, considering the depth of submergence, deemed it wisest to delay their use until efforts from the surface failed to rescue the men.

The high induction valve is situated within the fairwater at the after end of the conning-tower structure, and the intake of that valve has a diameter of 31in. After getting inside the pressure-resisting hull, the airline branches into two subsidiary mains, each controlled by a 17in. valve; and the airline extends forward and aft with diminishing diameter to carry circulating air to the other compartments, but the piping to the oil-engine intakes remains large because of the air needs of those machines. The high induction valve is opened and closed hydraulically from a control station in the conning tower, and the two 17in. valves are operated from below and were designed, if necessary, to be worked by hand. The high induction valve, other important valves, and all hatches indicate their status on a signal board in the control room below the conning tower—red lights indicating "open," and green lights "closed." Something went wrong with the electric signal circuit, because the green light showed when manifestly the high induction valve remained open. Up to the present, nothing has been made public about the reason for this misleading action, but it is known that the valve had not functioned properly on one or more previous occasions but, happily, in circumstances that did not invite a catastrophe. One of the civilian inspectors aboard at the time of the accident, a man of years of submarine experience, declared: "He didn't consider the present type of air-induction valve either efficient or effective."

Just before the "Squalus" dived in the morning of May 23rd, her commanding officer radioed the Portsmouth Navy Yard that he was about to start on an hour's submerged run. His vessel was then about 5 miles seaward of the Isles of Shoals and approximately 15 miles distant from the Navy Yard. The depth of water in the immediate area ranges from 223ft. to 257ft., and deepens more or less rapidly seaward. The "Squalus" had dived to 50ft. and was straightening out horizontally when word was sent up from the after part of the vessel that water was coming in and to return to the surface. Immediately, ballast tanks were ordered to be blown and the vessel started up towards the surface. Her bow attained an angle of approximately 40 degrees from the horizontal by the time the submarine began to settle stern first to the sea bed, where the impact drove a considerable part of her after body well into the mud. She came to rest on virtually an even keel and with her bow up at a slope of about 11 degrees. The forward marker buoy was promptly released, and thereafter, at intervals, smoke bombs were shot up to the surface to indicate that the "Squalus" was down and in trouble.

The failure of the "Squalus" to report her return to the surface caused anxiety at the Navy Yard after an ample margin of time was allowed, and the U.S. Submarine "Sculpin," a sister ship, was sent out to investigate. At 1.40 p.m., the "Sculpin" radioed that she had sighted a smoke bomb, picked up the marker buoy, and had been in communication by telephone, through the medium of the buoy, with the people in the fore part of the "Squalus" before a heavy sea broke the cable that held the buoy to the foundered vessel. That report indicated that a considerable number of the people aboard were alive and in no immediate distress. From that hour onward, the Navy's rescue and salvage equipment was directed to the scene of trouble, and steps were taken to have the area of the accident marked and guarded. No rescue efforts could be made until the U.S.S. "Falcon," Fig. 2, arrived from the Naval Submarine Base at New London, Conn., bringing a rescue chamber and a squad of divers qualified to work at a depth of 240ft. The "Falcon" reached her destination about 6 o'clock the next morning, and immediately began making preparations for re-establishing contact with the "Squalus" and getting the rescue chamber ready for putting overboard.

The first Navy diver went over the side of the "Falcon" at 10.15 a.m., and reached the deck of the "Squalus" seven minutes later, where he made fast a descending line which served to guide a downhaul cable for the rescue chamber. The first diver remained on the submarine until he had shackled the downhaul cable to the spindle of the forward escape-hatch cover. The speed with which that difficult work was done cleared the way for the operation of the rescue chamber in its first application in saving life. The rescue chamber made its first descent about one hour after the diver had attached the downhaul cable to the forward escape hatch; and during the remaining hours of May 24th, the chamber made four descents and three return trips to the surface, bringing up on those three trips 25 of the living men without a hitch in the operations. Trouble developed only on the fourth ascent, with the commanding officer of the "Squalus" and seven of his personnel in the chamber. The upward trip which started out all right was halted when the chamber was about 150ft. below the surface, at which point the downhaul cable became jammed—probably kinked because it was paid out too fast—and nothing could be done from within the chamber to relieve the situation. After two divers had been sent down to see what the trouble was, and had failed for one reason or another, a third diver went down and succeeded in cutting the downhaul cable, but that was only a partial solution of the problem. The chamber could not be allowed to float free to the surface with its normal positive buoyancy lest it acquired considerable speed and came up under one of the salvage flotilla and possibly gravely hurt the men inside of her. The solution lay in almost completely destroying the positive buoyancy, and, by juggling the water ballast to this end, the

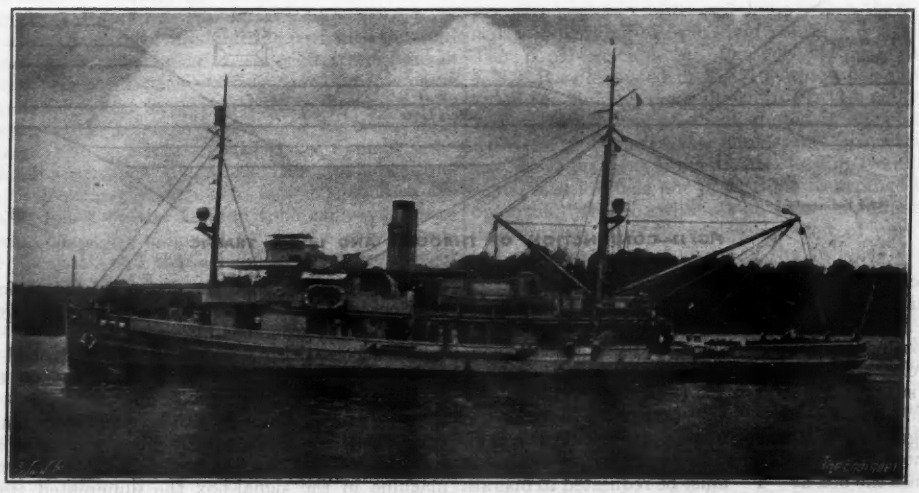


FIG. 2—U.S. RESCUE SHIP "FALCON"

operators finally landed the chamber on the sea bed with negative buoyancy. The chamber all the while was in telephonic communication with the "Falcon" and orders were sent down to adjust the water ballast so that the chamber would have a dead weight that would slightly overcome buoyancy; and with that dead weight the chamber and the ten people in it were pulled up by hand by the crew of the "Falcon," using the ⅞-in. lifting line shackled to the top of the chamber. That upward journey had originally started about 8.50 p.m., and was completed at 12.30 a.m. following. Fortunately no one was the worse for wear for the long and what must have been at times a rather trying confinement in the rescue chamber.

From the time the "Squalus" sank and up to the departure of the last 33 known survivors in the forward part of the boat, no signal had been received by those men that anyone remained alive in the after flooded compartments. Neither had the first diver who had attached the downhaul cable for the rescue chamber received any signals from the afterbody as he had from the men inside forward. Nevertheless the Naval authorities decided to use the rescue chamber on the after escape hatch to ascertain whether or not there could possibly be any survivors in that section of the vessel. In that case, the work was extremely hazardous, because the chamber had to function finally as a diving bell and directly opposite from

FIG. 3—RESCUE CHAMBER ON THE "FALCON"

the way it was operated in rescuing the men through the forward escape hatch. After the chamber was secured over the after escape hatch, the pressure in the interior of the chamber was built up until the compressed air was nearly equal to the outlying hydrostatic pressure, and then the escape-hatch cover was released by one of the crew of the chamber just enough to ease it slightly off its seating. The water and air that escaped indicated that the after body was flooded and no living members of the personnel remained there. The hatch cover was immediately reseated and the chamber was made ready for release from the submarine, sealed up, and the ascent carried out very deliberately to allow for the decompression of the two divers within it by gradually lowering the air pressure until it was back to atmospheric before the chamber reached the surface. The two divers engaged in that particular use of the rescue apparatus were especially commended for the courageous work done by them. If anything had gone wrong, nothing could have been done from the surface to aid them.

RESCUE CHAMBER

The rescue chamber, Figs. 3 and 4, was devised after the U.S. Submarine "S-4" was sunk, while running submerged in the waters adjacent to Provincetown, Massachusetts, on December 17th, 1927. That boat was struck by a Coast Guard destroyer, and all forty within the submarine at the time lost their lives eventually. An officer and five of the crew sought security forward in the torpedo room, and for more than 60 hours made and received tapped signals, and finally died because stormy weather and none of the facilities available would permit the lifting of the bow of the stricken craft so that the imprisoned men could get out. The "S-4" sank in water 102ft. deep. The rescue chamber was conceived by Commander Allen R. McCann, and progressively developed to its present form. Until used on the sunken "Squalus," none of the five rescue chambers in the service had ever gone down to a depth much greater than 100ft., and then only in carrying out training exercises, at specified intervals annually, so that men would always be available to handle any of the chambers should an emergency arise.

The submarine rescue chamber in its present form is a steel structure capable of withstanding an exterior pressure of 165 lb. per square inch. It is 10ft. high, has a maximum outside diameter of 93in. near the top and tapers downward to 60in. at the open bottom, which is finished with a projecting rubber gasket that has a thickness of ⅞in. In the main, the chamber has three subdivisions: the large upper compartment; a smaller cylindrical lower compartment; and a tapered ballast tank which completely surrounds the lower compartment. The upper compartment is separated from the ballast tank and the lower compartment by a pressure-resisting floor in the centre of which there is a hatchway, with a submarine cover, which provides means of access between upper and lower compartments. On the dome of the chamber there is a hatch, with a raised coaming, which gives access to the upper compartment. The coaming can be drained by a valve that is operable either from within or without the chamber. Outside, at the top of the chamber are four watertight fittings: one for the air-supply line of 1in. wirewound hose; one for the air-venting line, of 1¼in. wire-wound hose; one for the telephone wire-circuit; and one for the electric-light cable. All these lines and cables have their upper connections aboard the salvage vessel at the surface. The air-venting hose is open to the atmosphere at its upper end.

The upper compartment contains all the operating gear with the exception of the reel or winch for the downhaul cable. It is the compartment in which the two operators and any passengers may ride. Within this compartment are: The operating motor with air-supply and exhaust lines and valves; the upper compartment blow valve; the upper compartment vent valve; the blow-and-vent manifold for the lower compartment and ballast tank; the water manifold for flooding and emptying the lower compartment and ballast tank, with a hose connection and valve for filling the movable adjusting tanks; fourteen movable, tanks; one caisson gauge; one sea-pressure gauge; the lighting system; the telephone to the surface ship; two portable battery lamps; four holding-down rods; the access hatch to the top of the chamber and the access hatch to the lower compartment.

The operating motor of the winch is an air-driven unit similar to the drive of a pneumatic drill. It is geared to a reel situated in the lower compartment on which can be wound about 450ft. of 7/16in. plow-steel cable which forms the line for pulling the chamber down to the submarine or for allowing the chamber to rise from the submarine when the cable is unwound. The controller is on the air-supply line, and by the movement of the controller the direction of the motor's rotation is determined. When the controller is moved to its limit downward, the motor operates to reel in the cable. When it is moved to its upward limit, the reel slacks out the wire. A clutch and brake are fitted for use when it is desirable to slack the wire faster than the motor can run. The motor is so designed that it will stall before subjecting any part of the system to a breaking load, and can, therefore, be operated at full speed without danger of parting the wire cable.

The motor takes its air supply through an overhead control valve in the air-supply line that connects with the surface by means of the 1in. wire-wound hose. The exhaust from the motor is discharged, also overhead, into the vent line which runs to the connection on top of the chamber and through the 1¼in. hose line to an atmospheric outlet aboard the salvage vessel. The clutch of the motor is engaged and disengaged by lowering and by raising the upper clutch disc. A hand-operated brake encircles a driving shaft below the clutch.

The upper compartment blow valve is also overhead on the main supply line, and the vent valve for the upper compartment is in a similar position above on the vent line. The vent valve is not opened to the compartment when the air motor is exhausting into the vent line. For ease of identification, the air-supply line is painted yellow and the vent line red. The air-supply line terminates at the blow-and-vent manifold at one side of the motor. At this manifold, there are the blow valve for the lower compartment and the blow valve for the ballast tank, which, when opened, admit compressed air to the top of their respective compartments. On the blow lines from the valves to the lower compartment and to the ballast tank are vent valves. Both the lower compartment and ballast-tank vent into the upper compartment; and the air so discharged escapes thence to the atmosphere through the vent valve at the top of the upper compartment—in this way restoring the air in the upper compartment virtually to atmospheric pressure.

Just to the left of the blow-and-vent manifold is the water manifold, which consists of the sea valve, the lower compartment flood valve, the ballast-tank flood valve, and a valve, with a hose connection, for filling the adjusting ballast tanks. With the sea valve open, sea water flows into the

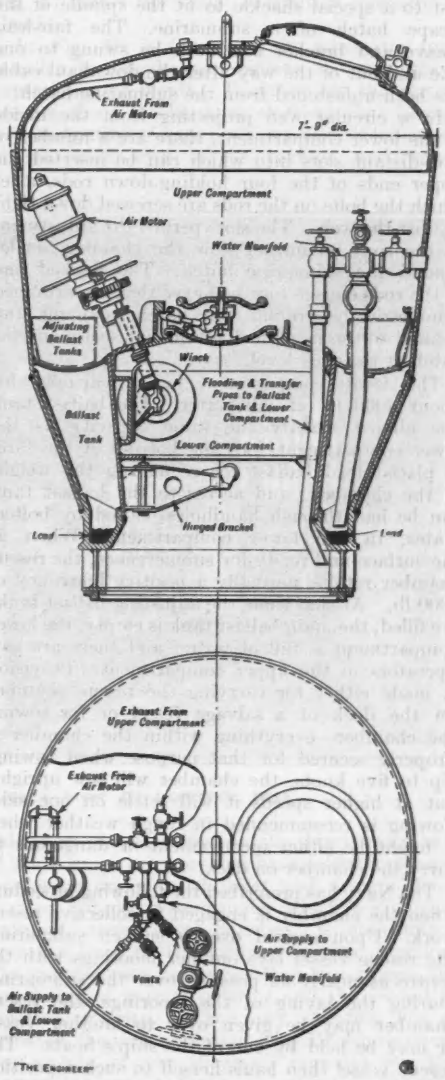


FIG. 4—SECTION AND PLAN OF RESCUE CHAMBER

hull and through a 3in. line to the two flood valves and to the hose valve. From the flood valves, 3in. flood lines run to the bottom of the ballast tank and the lower compartment, respectively.

Fourteen movable galvanised tanks are arranged in a circle around the inside of the upper compartment, affording seating for passengers and operators. Each tank has a capacity of 67 lb. of salt water. They are accessible and are used to compensate for gain or loss in weight of the chamber with the entrance or departure of passengers. They are filled by hose, as described, and they are emptied by dumping their water into the lower compartment when the connecting hatch is open between the two compartments.

In the upper compartment there is a caisson gauge that indicates the air pressure in the compartment and a sea gauge that indicates the hydrostatic head outside. They are on the chamber wall near the air motor. The electric-light cable links the fitting at the top of the chamber to the switchbox from which are controlled the

lights in the upper and lower compartments. Two portable battery lamps are secured to the hull in the upper compartment for use should the regular electric-lighting system fail. The telephone system is of the batteryless type.

Both hatches in the upper compartment—in the dome and in the floor—are of the latest submarine escape type and may be worked readily from either side. There are three eyeports in the hull, in the upper compartment; and there is also a single eyeport looking down into the lower compartment. There are stowed in the upper compartment four holding-down rods—hooked at the lower end and threaded and fitted with nuts at the upper end—for securing the chamber as a safety measure to the submarine hull when contact has been made in the manner to be described.

The lower compartment contains the downhaul cable and winch, a fairlead sheave, through which the wire cable runs, and a hinged bracket which serves as a fair lead for the wire and centres it in the compartment when the reel is winding the cable in or out. One end of the cable is secured to the reel and the other end is made fast to a special shackle to fit the spindle of the escape hatch of a submarine. The fair-lead sheave and bracket can both be swung to one side and out of the way after the downhaul cable has been unfastened from the submarine hatch.

In a circular web projecting from the inside of the lower compartment, there are a number of equi-distant slots into which can be inserted the upper ends of the four holding-down rods, after which the bolts on the rods are screwed down tight against the web. The slots permit the adjustment of the rods no matter how the chamber settles around the submarine hatch. The hooked end of the rods engage four pad-eyes that are arranged symmetrically around the hatch coaming and secured to the machined apron that surrounds the hatch at the deck level.

The lower compartment has a capacity for about 4000 lb. of salt water. The ballast tank has almost exactly the same capacity as the lower compartment. In the bottom of the tank is placed lead ballast for regulating the weight of the chamber; and access to the ballast tank can be had through handholes, closed by bolted plates, in the lower compartment. When at the surface and ready for submergence, the rescue chamber retains normally a positive buoyancy of 1000 lb. At that time, the adjusting ballast tanks are filled, the main ballast tank is empty, the lower compartment is full of water, and there are two operators in the upper compartment. Provision is made either for carrying the rescue chamber on the deck of a salvage vessel or for towing the chamber—everything within the chamber is properly secured for that purpose when towing. Up to five knots, the chamber will tow upright, but at higher speeds it will settle on one side. Towing is recommended in rough weather when it might be either inconvenient or dangerous to carry the chamber on deck.

The Navy has prescribed the following procedure when the chamber is engaged in collective rescue work. Upon arrival over a sunken submarine, the rescue vessel lays out her moorings with the centre as nearly as possible over the submarine. During the laying of the moorings, the rescue chamber may be given over to another vessel or may be held by one of the ship's boats. The rescue vessel then hauls herself to such a position that the submarine lies to leeward about 50 to 100ft. The chamber is then brought to the lee side of the rescue vessel and all connections are made.

The 1in. hose is connected to the ship's compressors or air banks and to the fitting at the top, outside, on the rescue chamber. The 1¼in. hose is secured with one end on board the rescue vessel, open to the atmosphere, and the other end to the proper fitting on the chamber. The telephone cable and the electric-light cable are plugged in at both ends to their proper fittings. All connections—air, vent, telephone, and light—are tested out before submergence. An air pressure at least 50 lb. greater than the water pressure at the depth at which the submarine lies should be maintained in the air-supply line. Once the various connections are made, the chamber can be fended off from the side of the salvage vessel until ready for the descent.

While this work is going on with the chamber, the diver is prepared for his descent, and should go down as soon as everything is in readiness. After he arrives on the submarine's deck, he first clears away everything from the submarine hatch that might interfere with the seating of the chamber around the hatch. Then the shackle end of the downhaul cable is sent below to him and he makes the shackle fast to the spindle of the submarine hatch. The diver is then brought to the surface, but stands by for a descent if his services should be needed by the crew of the rescue chamber.

With the chamber ready to descend, two operators enter it and close the upper hatch after them. Should more than two men be sent down, water ballast is left out of the galvanised tanks to compensate for the excess weight; and approximately the emptying of two of the cans takes care of the weight of one man. As the chamber descends, the hose, telephone wire, and light cable, bound together for convenience in handling, are paid out. The cable attached to the lifting pendent at the top of the chamber is also paid out. A strain is never placed on this wire, and it is used mainly to pull the chamber over to the rescue vessel after the chamber has returned to the surface.

When the submarine is listed to one side on the bottom, it may require some manœuvring to get the chamber against the seat and especially to get it reasonably well centred over the hatch. However, it is not impossible at any angle at which the submarine is likely to lie.

There are some conditions that may confront the operators of the rescue chamber that have to be taken into account. Before the crew of the chamber open the hatch of the sunken submarine, they must be prepared for a number of conditions within that craft. Only a few of these need be mentioned now, and any one of them places responsibility on the judgment and resourcefulness of the crew.

It is not unlikely that the submarine compartment will be punctured and sea pressure exist inside, with the men breathing in the air space above the water. This condition will make itself apparent to the chamber crew by air escaping around the edge of the hatch as the latter is cracked. The hatch should then be closed, a pressure equal to the sea pressure outside should be built up in the chamber, and then the escape hatch may be opened. After the passengers are removed from the submarine, taken into the chamber, and the escape hatch closed, the pressure must be vented through the upper compartment before the chamber is unsealed from the submarine. Proper decompression must be used during the venting period.

Another exigency may arise if the submarine's compartment contains chlorine gas or carbon dioxide. This will necessitate the use of the improved type of lungs as respirators by the chamber crew.

A certain amount of confusion may prevail below on account of lack of lights, &c. The handling of such a situation will depend upon circumstances.

A total of six average-sized men may be taken aboard the chamber, without reducing the reserve of buoyancy below 1000 lb., by emptying all the galvanised cans in the upper compartment. If it be deemed necessary or advisable to carry more, none of the adjusting ballast tanks should be dumped, but the chamber should proceed to the surface with the lower compartment empty. Under the latter condition as many men as the chamber will hold may be taken up. Twice during the rescue work on the "Squalus," nine passengers were carried to the surface, in addition to the crew.

The final operations of the crew of the rescue chamber before freeing it for an ascent are of the following order:

When the passengers and one of the crew are in the upper compartment, then the operator in the lower compartment closes and screws tight the submarine hatch, replaces the fair-lead sheave and bracket, and shackles the downhaul wire to the hatch spindle. The other operator then takes in all slack on the wire by running the motor with the controller in the down position. When the downhaul wire is taut, the operator in the lower compartment removes the holding-down rods and passes them up into the main compartment. He then enters the upper compartment. The next step is to dump into the lower compartment the water from the small tanks if that will compensate for the added weight of the passengers. With that done the hatch to the lower compartment is closed and preparation made for rising to the surface.

The rescue chamber was used to carry food and blankets down to the known living aboard the "Squalus." The time between descent and return to the surface in three of the trips averaged about two hours, and the same schedule would probably have been maintained had not the downhaul wire kinked and jammed on the fourth and last life-saving trip. The Navy Department has made public that experiments have shown that the air motor of a rescue chamber has sufficient power to seat the chamber against the deck of a submarine when the sunken craft lies at angles to the horizontal, both fore-and-aft and athwartship, up to 30 degrees. For angles in excess of 30 degrees an adaptor to suit such special cases, which however are not anticipated, can be readily provided. The Navy has in service five rescue chambers and five rescue ships, stationed at points of greatest submarine concentration; and training exercises are carried on continuously.

(To be continued)

Remote Supervisory Control

No. VI

(Continued from page 564, Dec. 8th)

THE Strowger supervisory remote control system, developed by Automatic Telephone and Electric Company, Ltd., of Liverpool, operates basicly on the impulse principle and utilises telephone relays and the simple Strowger selective components used extensively on automatic telephone exchanges. The equipments are made in two main types: (1) supervisory indicating and metering equipment as used on a large scale for control purposes on the British grid system, and (2) supervisory remote control equipment as employed on electric railways and power networks for the remote supervision and control of actual switching operations from a central point. Supervisory indicating equipments have been provided exclusively for the Central Scotland, North-West England and North Wales, South-West England and South Wales, and South Scotland sections of the grid, and equipment has also recently been installed in the South-East section. Each of the nine main grid sections has its own central indicating station connected for indicating and signalling purposes by a single telephone circuit, rented from the British Post Office, to one or more power stations and substations. The shorter circuits are metallically continuous, and on these D.C. impulses are used for signalling purposes, whilst in many cases the longer circuits pass through repeater stations and utilise impulses of voice frequency currents. Facilities offered by the signalling equipments are: (1) continuous indication of the position (*i.e.* whether "in" or "out") of each distant circuit breaking by means of miniature lamps; (2) continuous indication of the tapping on which each distant transformer tap changing switch is working; (3) visual and audible alarms when any change occurs in either circuit breaker or tap changing position; (4) telephone communication can be established between the central indicating station and each distant station with facilities for calling in both directions; (5) standardised instructions may be sent to the operating room staffs by means of a system of engine-room telegraphs; (6) remote metering provides for the summated kW and reactive kVA components on distant transformers and the total loads on the generating stations are indicated at the central indicating station.

In certain cases, the A.T.M. Strowger apparatus is used to provide the important feature of intertripping of circuit breakers. This ensures that in the event of any circuit breaker being tripped owing to a line fault, the companion breaker at the other end of the line is automatically tripped in usually less than a second. This facility is provided over the same telephone circuit as is used for the other services.

At the central indicating station the apparatus consists mainly of an indicating board giving indications of the 132 kV oil circuit breakers, tap changing switches, and essential meter readings, an engineer's control desk provided with a manually

operated miniature system diagram, a manual telephone switchboard, and signalling apparatus racks. On racks at the sub-stations the A.T.M. Strowger supervisory apparatus is accommodated. Line isolating equipment is included to protect the rented Post Office telephone circuits from possible damage by dangerous earth potentials under fault conditions on the E.H.T. lines.

In general it is not possible to provide direct quantitative metering over a long telephone circuit, especially because the reading required is usually power in watts which is the product of two vector quantities, each of which would have to be transmitted both in magnitude and in phase. A considerable number of telemetering systems have been designed. Many have incorporated the A.T.M. remote indicating schemes, and not a few have made their appearance as part of the grid signalling system.

In the early days of the grid the load on any particular circuit was not subject to rapid and unforeseen changes and was as a rule far below the full load of the circuits. Hence a system whereby any one meter reading could be obtained at will by selection fulfilled requirements. The next step was to provide a number of readings required by the control engineers in quick succession. Both these systems operated on the impulse principle in which the number of impulses was proportional to the quantity being measured. With more extensive interconnection and heavier loading of the power circuits, however, high

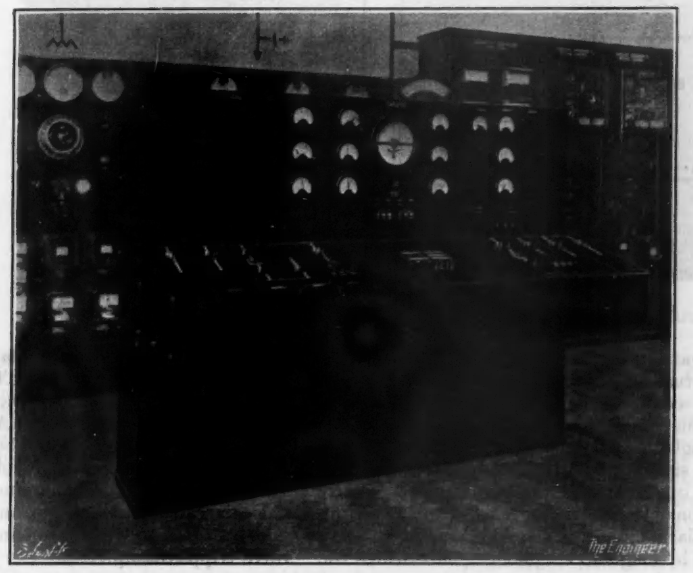


FIG. 45—CONTROL DESK

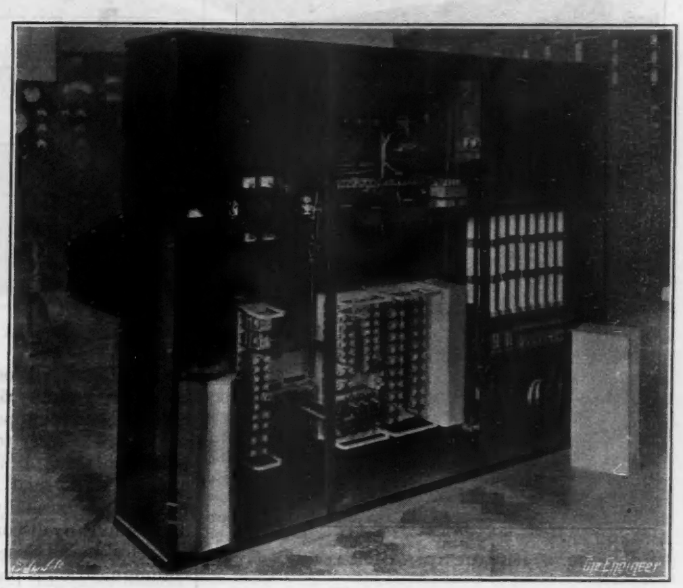


FIG. 46—BACK VIEW OF CONTROL DESK

unpredictable interchanges of load between different districts can occur, and it became essential to devise a system whereby several simultaneous readings could be provided continuously over a single circuit without mutual interference. These readings were required to be given continuously so that any undesirable interchange of power could be noticed and reduced immediately it occurred. A photo-telemetering system was accordingly developed by the Automatic Telephone and Electric Company, incorporating photo-electric cells and rotating lens-prisms, enabling not only several meter readings to be indicated continuously and concurrently over a single telephone circuit, but telephone communication and the ordinary indicating signals to proceed over the same circuit without mutual interference.

Owing to the large number of different signals that are required to be transmitted over the single telephone channel, connecting each sub-station with the central indicating station, a definite order of priority has to be allotted to each class of signal, and means have to be provided to avoid the loss of any signal that may be temporarily impeded by a signal of higher priority. It is recognised that whilst the circuit breaker inter-tripping feature must of necessity have the rank of highest priority, the indications of circuit breaker positions should have the next rank. This means, for example, that if in the course of transmitting a telegraph instruction a change occurs in the circuit breaker position, the signal associated with this change must seize the line and interrupt for the time being the transmission of the telegraph signal.

Whenever the position of a circuit breaker changes, whether as a result of an instruction from the central indicating station or as the result of a fault or overload, the supervisory equipment rapidly checks the indications of all circuit breakers in the particular sub-station and causes the lamp indicator corresponding to the particular change to be connected and caused to flicker. At the same time an alarm bell is rung until the change of indication is observed and acknowledged by the control engineer at the central indicating station.

When the position of a circuit breaker is changed, not only is the position of each of the other breakers at the particular sub-station also checked, but on certain grid areas a complete set of meter readings is received as well. By means of this arrangement the control engineers are immediately in possession of complete information concerning the location of the cause of the change and also its effects on the distribution of the load.

At the central indicating station the control engineers have a check key for each sub-station, and these enable the supervisory apparatus to be exercised and the indications checked or a complete new set of meter readings to be taken for logging purposes, &c., at any time.

The telephone facility is arranged to give a limited number of important routine instructions to the operating room staffs. These instructions are concerned with the generating plant and enable the load being taken by any station to be quickly controlled from the central indicating station. The telephone facilities are used for general operation purposes. When a telephone connection is interrupted to permit a signal of higher priority to be transmitted, the duration of the interruption can be arranged not to exceed two and a half seconds, after which the telephone connection is automatically re-established.

A good example of the Strowger system of remote supervisory control system is provided by its application to the Galloway Water Power scheme having five hydro-electric power stations with an aggregate capacity of 100,000 kW, two of the stations being completely unattended and remotely controlled. The Strowger equipment provides for the remote control and indication of circuit breakers, transformer tap changing gear, water intake gates, starting, speed and excitation control, synchronising, load control, and shutting down of generators, &c., telephonic communication, remote indication of water levels, meter readings, water intake gate and valve positions, alarm signals of high generator temperatures, oil lubricating flow, disconnection of pilot lines and blown fuses, &c.

Originally mainly designed for the purpose of supplying power to the grid, it is possible with the scheme to run up the plant under emergency conditions, synchronise it, and load it to full capacity in less than ten minutes. The five stations are at Kendoon, Carsfad, Earlstoun, Glenlee, and Tongland. The Kendoon, Glenlee, and Tongland stations are attended, but Earlstoun and Carsfad stations are remotely controlled from Glenlee. The indicating and remote control equipment was installed in two stages. Stage I dealt with Tongland and Glenlee whilst Stage II related to the remote control of Earlstoun and Carsfad, and provided telephone communication for Kendoon. At a later date certain remote control apparatus was installed at Kendoon for controlling the intake gate at the Blackwater Burn.

For Stage I the remote control and indication scheme may be summarised as follows:—(1) Remote control of six intake gates situated at Glenlochar barrage and indication of gate positions; (2) remote indication of water-level at the barrage; (3) remote indication of water flow on the downstream side of the barrage; (4) indication of flood conditions at the barrage; (5) indication of failure of the 400-volt gate operating supply; (6) water-level at Tongland dam indicated and recorded at Tongland power station; (7) telephone communication. At Glenlee the facilities offered are: (8) remote control and indication of the closing of Clatteringshaws intake gate; (9) remote control and indication of the tripping of the Glenlee portal valve; and (10) telephone communication. Facilities (8), (9), and (10) may also be provided at an emergency kiosk situated on high ground near Glenlee power station. Front and back views of one of the two control desks for the remotely controlled power stations are shown in Figs. 45 and 46 respectively, whilst Fig. 47 shows the visual instruction indicator at Glenlee.

In Fig. 48 is illustrated in schematic form familiar to telephone engineers the supervisory control arrangements. Facilities for the remote control of six intake gates at Glenlochar barrage with indication of gate positions, remote indication of the water-level at the barrage, and remote indication of water-flow on the downstream side of the barrage are provided by a selective scheme employing one pair of wires and using a fixed number impulse system under which a complete train of twenty-five impulses is transmitted over the lines to Glenlochar for each selection. The impulse train is composed of two groups, the first being of normal polarity and the second of reversed polarity. When any selecting key is actuated, the slow operating relay CE (shown near the middle of the diagram) operates *via* the interrupter contacts S of uniselector S in line with it, uniselector wipers of S and SX on their home contacts and the operated common contacts of the particular selecting key. The operation of relay CE energises the magnets of uniselectors S and SX and interrupter contacts S then open to disconnect and release relay CE. The two uniselectors thus step from their "Home" contacts, whereupon the interrupter contacts S remake to reoperate relay CE *via* the wiper of S. Relay CE and the uniselector S thus interact at about 10 steps per second for a full cycle of twenty-five steps, uniselector SX likewise stepping until relay RV in the lower part of the diagram operates and locks up when the individual contact of the particular selecting key is reached. During impulsing the slow releasing relay COR remains steadily operated and holds relay CO operated, thus completing *via* the pulsating contacts CE the line circuit for relays N and R at Glenlochar as shown on the right of the diagram. Relay N responds to pulses of normal polarity and controls the stepping of uniselector A, whereas relay R operates on reversed pulses to step uniselector B. The change over from normal to reversed pulses occurs when relay RV at Tongland operates and locks up.

Hence uniselector SX at Tongland and uniselector A at Glenlochar make the same number of steps which may be any number from 1 to 24, whereas uniselector B makes the complementary number of steps, *i.e.* 24 to 1.

Upon completion of the selecting train of twenty-five impulses, relay H operates at Glenlochar *via* uniselector wipers A and B on their complementary contacts, whilst relays HT and H operate at Tongland and thus introduce relay MH which operates and holds relay CO to maintain the line circuit. The particular selection lamp at Tongland then glows to show that the desired selection has been made. These selection lamps are connected to another bank of contacts on uniselector SX, not shown in Fig. 48.

The gate position indicating circuit is shown at the top of Fig. 48. A moving arm of a 1200 ohms variable resistance is geared to the control mechanism at each gate and follows the gate movement. Hence the position of the gate at any time can be determined by reading the value of the resistance in circuit. Water-level and water-flow indications are obtained in a similar manner, but in this case the variable resistances are operated by floats. Water-level and water-flow recorders are operated continuously from a local battery and use the variable resistances associated with their respective indicators. The indicators read at one end of the resistance and

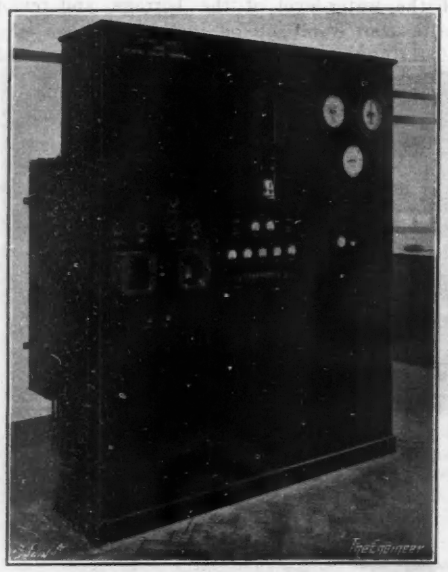


FIG. 47—INSTRUCTION INDICATOR

the recorders at the other end. There are two positions for the gate selector keys, "raise" and "lower." When it is required to raise gate No. 3, the key is thrown to "raise." At the end of the impulse train relay H at Glenlochar operates and connects the variable resistance to the line. At Tongland relays CO and H are operated and relay HT operates to unclamp the ohmmeter and connects it to the line, when the gate position is at once indicated.

As regards gate control upon completion of the selection operation, depression of the "operate" key operates relay OP at Tongland, and this reverses the line current causing relay OPS at Glenlochar to operate. Relay OPS operates relay OPX, which completes the circuit for the "raise" gate control relay, and this causes the motor to operate the gate. Other contacts on relay OPX also close the circuit for the adjustable time limit relay TL which is adjustable within 1 to 20 seconds. This relay is normally set to operate after a period of two seconds and its operation shuts down relay OPX, which therefore releases and disconnects the gate control relay. The period of two seconds permits the gate to move a distance of 3in. As the indicator is on the line throughout this operation, its pointer follows the movement of the gate. Further operation of the gate can be made by again actuating the operate key, each operation giving 3in. movement. When the selection key is restored to its normal position, the indicator is reclamped and all other equipment is released. If the selection key is thrown to "lower" the uniselectors are stepped to the next set of contacts and the "lower" gate control relay can then be operated in a similar manner to that for "raise." A check upon all indicators can readily be obtained at any time by operating the meter check key. This causes eight selections to be made in strict rotation, each indicator then being connected to its associated variable resistance over the line.

A water-level float at Glenlochar barrage is provided with a pair of contacts which make when the level of the water exceeds 41·5ft. Upon the closing of these contacts, an impulse train is sent to Tongland and causes the operation of a magnetic locking relay which in turn closes a visual and audible alarm circuit. Should the Glenlochar 400-volt supply fail, the release of a pilot relay causes the transmission of an impulse

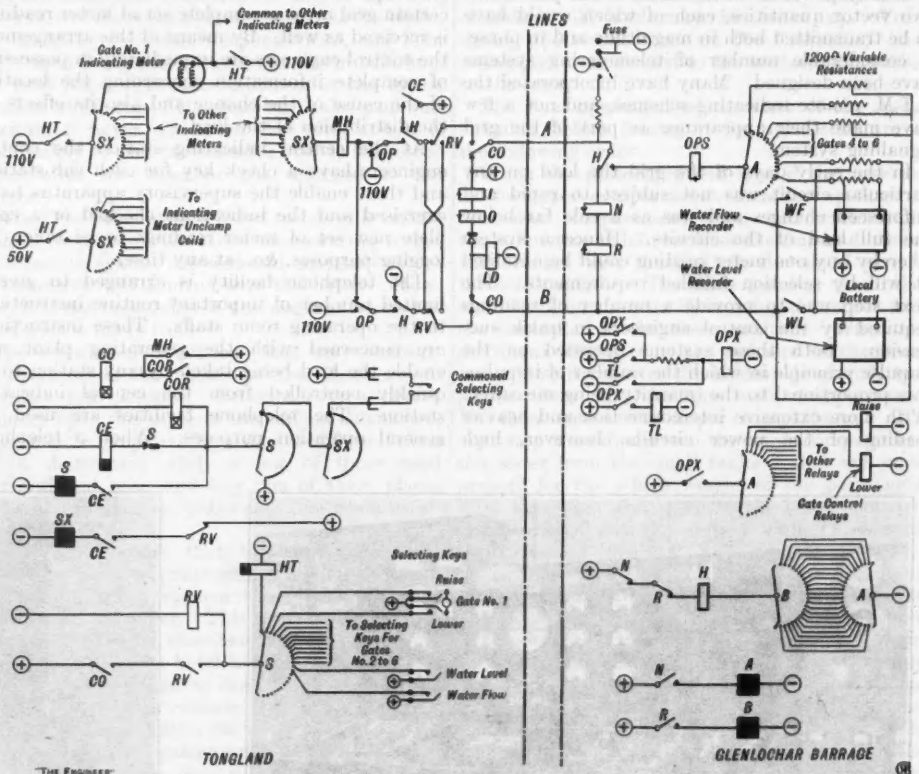


FIG. 48—SUPERVISORY CONTROL ARRANGEMENTS

train as described for the water-level alarm, whilst the blowing of any 50-volt fuse on the supervisory remote control apparatus connects the negative pole of the battery to the line "A." This operates polarised relay I at Tongland and gives both audible and visual alarm signals. At Tongland relay LD is normally held operated over the loop and should any disconnection of the line occur, relay LD releases and closes the alarm circuit. Telephone communication is provided by magneto telephones.

As part of Stage I of the scheme, provision was made to remotely trip, *i.e.* close, from Glenlee the Clatteringshaws intake gate and the Glenlee portal valve. Both the gate and valve are normally operated locally, the remote control apparatus only being brought into service under emergency conditions. The gate controls the amount of water released for Glenlee and the valve is situated at the end of the 3½-mile tunnel through which the water is led to Glenlee, where the line protection and relay equipment is housed in a cubicle control cabinet similar to that provided for Tongland. Two rotary type control switches, one for each circuit, are arranged to be operated from the front of the cabinet, the indicating lamps being mounted immediately above their associated switches. At the portal valve house and the Clatteringshaw switch house, the protection and supervisory control equipment is fitted on wall mountings.

"Fixed number" impulse signalling is employed similar to that described for Tongland, but as only a single control is required to be made on each circuit, the impulse train has been reduced to twelve impulses.

Operation of the gate control switch causes an impulse train to be sent over the line to Clatteringshaws, where uniselectors step a complementary number of steps to the "gate open" position, and so close the circuit for the gate interposing relay, which then completes the circuit for the driving motor of the gate mechanism. When the gate has fully closed, a pair of contacts close and short circuit the resistance normally across the line as shown schematically in Fig. 49. The reduction in loop resistance thus brought about causes the marginal relay MC at Glenlee to operate, and so light the gate tripped lamp and an audible signal is also given. The circuits for the "line disconnected" and 50-volt fuse alarms are given in a similar manner to that described for Tongland.

The portal valve tripping circuit is similar to that of the Clatteringshaw gate except that two indications are given, namely "trip started" and "trip completed." After the selection operation and when the valve begins to close, it closes a pair of contacts which operate and lock up relay TA, Fig. 49, and two contacts of this relay then close to reduce the total line resistance. Marginal relay MV is thus caused to operate and light the "valve started to trip" lamp. When the valve has fully closed, another pair of contacts close to operate relay TB, the operation of which releases relay TA. Whilst one pair of contacts of relay TB maintains the same reduction of line resistance as was previously accomplished by relay TA, another pair of TB contacts disconnect a further 100 ohms for the loop and also introduce a 30-volt booster battery. In this way a second marginal relay MVT at Glenlee is caused to operate and extinguishes the "valve started to trip" lamp and substitutes the "valve tripped lamp."

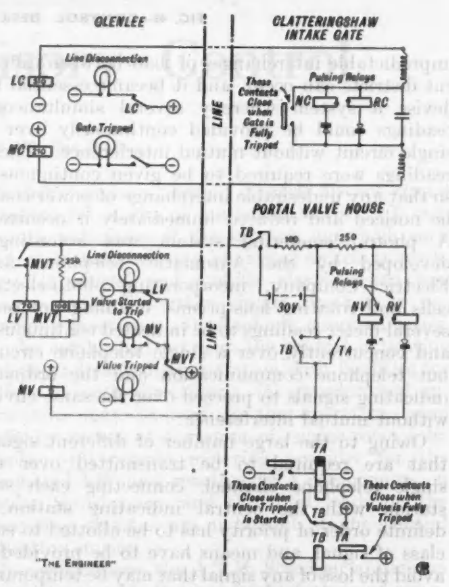


FIG. 49—GATE AND VALVE INDICATING CIRCUIT

In the emergency tripping kiosk the circuit arrangements are similar to those described, except that only one lamp signal is provided to indicate the "tripped" condition of the gate or portal valve. To trip either the gate or the portal valve from the kiosk it is only necessary to actuate one of the two keys, whereupon a train of twelve selection impulses is transmitted to either the gate or portal valve equipment, the lamp finally glowing to indicate the completion of the tripping operation.

(To be continued)

The Farjsund Bridge, Finland

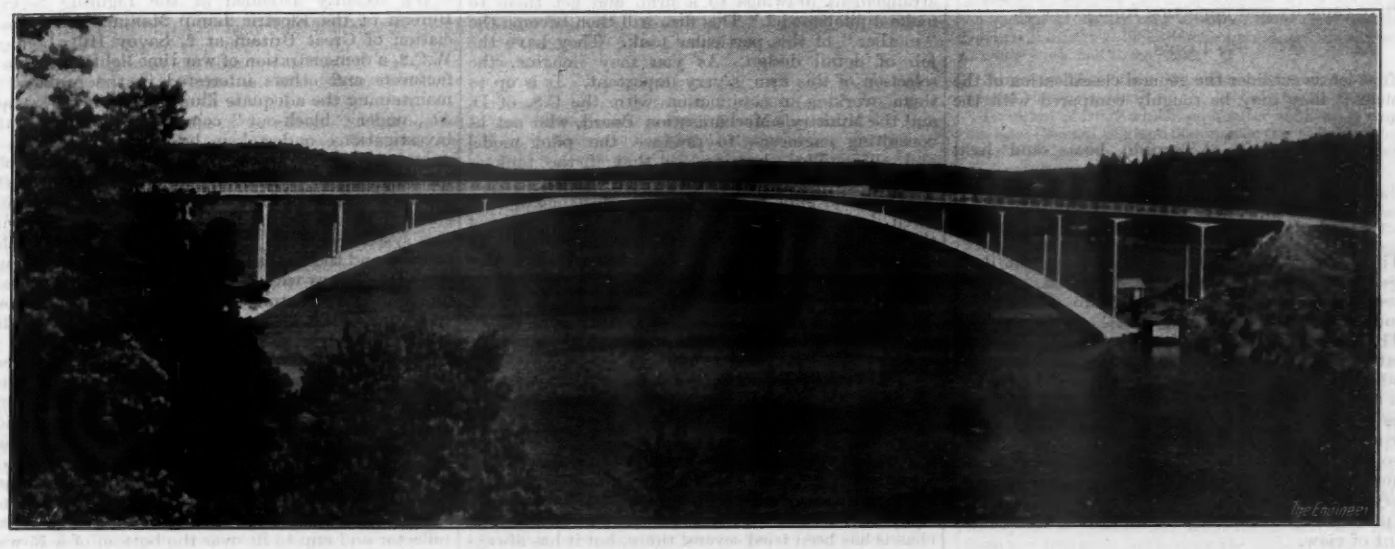
To unite the two shores of the Aaland gulf in Finland, the reinforced concrete arch bridge, illustrated by an engraving below, has recently been built. The contract for its erection was let to Monberg and Thorsen, A. B., of Stockholm, and Professor Dr. H. Granholm acted as consulting engineer for the contractors. The new highway bridge consists of a reinforced concrete arch and two reinforced concrete girder approaches, each comprising two spans of 49ft. and 44ft. The bridge has a width of 21ft., and carries a 16ft. 6in. roadway and two footpaths.

The arch was designed with fixed ends and has a theoretical span of 426ft. and a corresponding rise of 58ft. 6in., giving a rise span ratio of 0·135. It is of twin-cell box section, consisting of upper and lower slabs connected by one inner and two outer longitudinal diaphragms. The box is 3ft. deep by 15ft. wide at the crown and 8ft. 6in. deep by 19ft. at the springings. The top and bottom slabs are 13in. thick at the crown and 10½in. thick at the springings; and the thickness at the quarter points is 9in.

The permissible stresses adopted in designing the bridge were 17,000 lb. per square inch, for the reinforcement, 1020 lb. per square inch for the concrete in the arch ribs, and 820 lb. per square inch for the remaining concrete work. The arch is fixed at both ends and the computation of the stresses was made in the usual way, taking into consideration the eccentricity at the crown.

The arch was designed to resist the forces and moments due to dead and live loads, variation of temperature of ± 40 deg. Fah., shrinkage, wind pressure, eccentricity due to the difference between the polygonal theoretical arch line and the actual continuous line and bending moments due to the column action on the arch. The maximum calculated bending moments are 718 feet-tons at the crown and 3,722 feet-tons at the springing.

The south abutment of the arch was built above water level, but the foundations for the northern abutment had to be carried down 6ft. 6in. below water level in a cofferdam. The centering for the arch was carried down to the rock by means of piles. On the piles the falsework was erected to support the shuttering for the bottom slab of the arch. The arch was constructed in sections. After completion it was opened by the jacks in the usual way, and the centering was then removed. When the crown of the arch had been regulated to the exact height, taking into account the temperature of the concrete, the gap between the two half-arches was filled with concrete. A period having been allowed during which the concrete hardened the jacks were removed, and the pockets, in which the jacks were inserted, were filled with mortar. The arch then became self-supporting and the forms for the columns and later for the decking were erected.



FARJSUND BRIDGE, GULF OF AALAND, FINLAND

Army Vehicle Supplies

AT a conference held by the Ministry of Supply at the Royal Society of Arts Building, 18, John Street, Adelphi, London, W.C.2, on Monday last, December 11th, the Director of Mechanisation, Brigadier J. S. Crawford, M.I. Mech. E., accompanied by a representative of the Imperial General Staff, dealt with the subject of tracked and wheeled vehicles, including tanks. An account, outlined below, was given of problems which present themselves to the Imperial General Staff, and which are handed on to the Ministry of Supply, which is responsible for design, production, and delivery.

Following the conference visits are to be paid to representative works and factories at which vehicles, including tanks, are made, and in a forthcoming issue we hope to give a description of their work.

WHEELED VEHICLES

At the present time, the Ministry of Supply is the world's biggest buyer, at any rate of the heavy types, of mechanised vehicles, if not of others.

Wheeled—as distinct from tracked vehicles—required by the Ministry include: motor-cycles, light cars, heavy cars, infantry trucks, machinery lorries, searchlight lorries, mobile offices and sterilising plants, mobile laundries and laboratories, four-wheeled drive Field Artillery tractors, anti-tank gun carriers, ambulances, mobile workshops, wireless trucks, water tanks, six-wheeled load carriers, workshop stores, winch lorries, and anti-aircraft tractors. There are something like 50 different types of specially designed bodies. All this is in addition to tanks. It is, as may be seen, a large and varied field.

Design begins with the requirements of the General Staff, and those requirements begin with tactical considerations. In co-operation with the General Staff and the industry, the Ministry has to translate tactical requirements into terms of finished products. At times the General Staff asks for the impossible. The Ministry has to try to produce it. In fact, as noted elsewhere, the completely ideal vehicle does not exist. But there are some first-rate approaches. Every vehicle must, in the nature of things, be a compromise.

The General Staff sets tactical problems, with very open specifications. By discussion there is gradually evolved the vehicle to do the job. An experimental model is produced and put through the most exacting trials. Vehicles are tested for mechanical efficiency as such, and there are trials with the troops to make sure that the vehicle is all right in practical application. When it is satisfactorily through its trials the vehicle is put into production.

In peace time this procedure is a comparatively simple matter. There is no extreme urgency. Delivery date is governed by the fact that the vehicle must be ready in time for the training season: it is no use producing a new model to be tried by the troops when training is virtually over for the year. It is known, as a rule, that requirements are for the Spring. Again, in peace time, there is available, well in advance, a reasonable estimate of requirements in quantity. And, of course, it is nothing approaching the quantity being produced at the present time. There is leisure to experiment with new designs.

War changes the picture. Not only is demand immensely expanded, but the element of surprise and change with the consequent requirements of capacity for rapid adaptation of production must be kept constantly in mind. For example, it is quite possible, although it has not yet occurred, that the enemy will produce a more powerful anti-tank weapon which would necessitate re-designing our tanks. Changes in the nature or locality of warfare may require changes in transport. At the same time, during war, we have to produce in great quantity those types of vehicles which have already been tried out and proved.

At the present time we require more productive capacity for the heavy types of wheeled vehicles than actually existed in this country before the war. With certain provisions for the export trade—the importance of which in war as in peace we cannot afford to overlook—all the productive capacity in the country is being taken and added to as rapidly as possible, in respect of capacity for producing the heavy types of vehicle—lorries and trucks. Car capacity there is in plenty. Unfortunately a great part of it is not readily adaptable to the production of the heavy types. The very fact of mass production of cars makes adaptation more difficult: machines are specialised and often entirely unsuitable for production of heavy vehicles.

As an example, malleable cast iron and stampings may be taken. At the beginning of the war, the industry had ample capacity for the smaller, lighter kinds, but not for the heavy ones needed in greatly increased quantity. This was one problem which called for closest co-operation between the industry and the Ministry of Supply, and it has been overcome.

We have to adapt, as quickly as possible, light car productive capacity to our present war purposes. In this connection at one works alone, which has been adapted in this way, there is now being produced in a single day as many lorries as the entire British Army possessed at the outbreak of war in 1914.

The present rate and expansion of production would not have been possible except for planning and co-operation with the British industry before the outbreak of war. Armies were being mechanised abroad just at a time when the policy of this country was to disarm. We could not afford to overlook the new developments in transportation. We could not expand then, but we could prepare the way, in co-operation with industry, whereby expansion might be achieved should need ever arise.

That was done. We took the British motor industry into our confidence and have had their fullest co-operation ever since. We tackled our problem on the lines of using standard commercial production vehicles as far as possible. These vehicles, however, had to be modified, even in peace time in certain directions to make them suitable for the tasks they would be required to perform on active service.

Commercial tyre equipment, for example, as provided for operation on main roads is entirely unsuitable for operation across country where conditions of sand, mud, gravel, or plough are met. For this type of terrain tyres of very large section, prominent tread, and big deflection are necessary. To accommodate these tyres, special wheels are also necessary and in turn special means of attaching them to the vehicle hubs. To permit of this modification being carried out to commercial vehicles, manufacturers were asked to standardise suitable hubs and stud fittings on their peace-time commercial production. Other directions where commercial vehicles have to be modified are clearance, gear ratios, and suspension.

Where a simple modification, as indicated above, would not produce a vehicle suitable for a certain role, a special design had to be embarked on, but in producing such design, endeavour was made to incorporate as many commercial components as possible. For example, the infantry type truck, although a specially designed Ministry of Supply vehicle, can be taken as being constructed of 85 per cent. standard commercial components.

Similarly, with the field type of artillery tractor, where all-wheeled drive is essential, the only special features required were the transfer box and power take-off from the main gear box to drive the front wheels and a winch respectively, and a special front axle to provide for the front wheel drive. In producing these designs and modifications the motor trade as a whole has been most helpful.

This policy has resulted to-day in an unprecedented production of vehicles after only 12 weeks of war, for it must be remembered that factories had to close down on their commercial vehicle and car lines and turn over to war-time production.

Tyres have been mentioned. Since the last war, of course, tyres especially for the heavier type of wheeled vehicles have changed beyond recognition. In those days we had lorries with an average speed of from 15 to 20 m.p.h. They ran on solid tyres, and even at that speed solid tyres sometimes burned out. To-day

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lorries run at speeds up to 50 m.p.h.—and they run on pneumatic tyres. In this respect, nowhere in the world are better pneumatic tyres made than those produced for the Ministry of Supply in this country. We are ahead of any other nation in tyre design.

The Ministry and the Army have been chided for an alleged neglect of "bullet proof" tyres. It is of interest to know that this country led the way and still leads in the design and production of "bullet proof" tyres. We began during the last war. Years of experimentation followed. For some considerable time our 15 cwt. trucks have, in fact, been fitted with "bullet proof" tyres. Now we have one of improved design and performance. Whether the "bullet proof" tyre is bullet proof or not is a subject of technical debate. At any rate it is bullet proof in the sense that it does what is wanted, and it is not bullet proof in the sense that the bullet does not bounce off.

As with heavy vehicles, so with tyres: the Ministry of Supply is now by far the largest buyer in this country, and probably in the world. It is at present employing the entire productive capacity of the British industry—except for that engaged in other war production. It is, in addition, expanding productive capacity and importing from overseas.

TANKS

First let us consider the general classification of the vehicles; they may be roughly compared with the Navy, thus:—

(1) Scout Cars (2) Armoured Cars	Torpedo boats and light destroyers.
(3) Light Tanks.	Destroyers.
(4) Cruiser Tanks.	Cruisers.
(5) Infantry Tanks.	Battleships.

There are two other types the department deals with—carriers and armoured command vehicles. These vehicles carry armour but are not fighting vehicles.

The General Staff lay down the policy. They say what they want and it is up to the Ministry to try and produce it. At times they ask for the impossible, and the department produces the best it can, and then tries to persuade the General Staff that it will suit their purpose. The very closest liaison is of course absolutely essential between the Ministry and the General Staff. As may be imagined, in actual fact, every vehicle must be a compromise. It is impossible to produce the completely ideal vehicle from every point of view.

As an illustration, the General Staff send over a G.S. Specification; it gives what the vehicle has to do in broad outline. As an example the requirements are purposely made ridiculous in certain places both to illustrate where compromise comes in and secondly bearing in mind that we do not want the enemy to know along what lines we are thinking.

(1) *Armament.* We are told the type of weapons the vehicle has to carry. Let us say, three Light M.G.'s, an A/T gun, and a Howitzer. Guns to have alround traverse except 1 M.G., which need only have 25 deg. either way.

At this stage the quantity of ammunition to be carried may not be specified, on the other hand, it may. It must be known at an early stage because stowage comes in, also weight.

(2) *Armour.* The Ministry is told what weapon must be kept out. Let us say the German 75 mm. firing A.P. shell.
(3) *Performance.* (*a*) Speed road cross-country; (*b*) Circuit of action; (*c*) Trench crossing; (*d*) Vertical climb; (*e*) Slope.
(4) *Communication.* Wireless type of set.
(5) *Crew.* Particularly the number of men in the turret.

It will be seen that the Ministry are given an entirely free hand as to the type of vehicle that is produced as long as it fulfils the requirements.

Obviously armament and armour are the main factors as far as weight is concerned—weight is the chief factor when considering performance. Sometimes the maximum weight of the tank is specified by the General Staff because of bridge crossing or carriage by rail.

The problem is now one for the Chief Superintendent of Design. This department produces a general arrangement drawing of the proposed tank. The Director of Artillery will be consulted with regard to the weapons. He advises what ones should be used for the job and gives full details. The armour has to be considered; what is required is the thinnest possible, every millimetre making a difference to the weight. If results are available, all well and good; if not, it is necessary to carry out firing trials to determine the type and thickness required. Probably the enemy gun or ammunition is not available and so the D. of A. is again consulted to find out what is the nearest equivalent weapon.

At this stage, the department may have to go back to the General Staff and say the task they have set is impossible, giving the reasons and offering alternative suggestions. It is for them to decide where they will give way. Armour, armament, or performance. In due course the general arrangement drawings are completed. During this period, of course, various other problems have had to be gone into and decided; some of them are as under:—

(*a*) Transmission—of course, including engine gear-box, reduction gears, &c.
(*b*) Suspension—most important as on it depends the gun platform.
(*c*) Type of tracks. Again very important from the performance of the vehicle. Pressure per square inch is a vital factor.
(*d*) Steering—quite a considerable problem.
(*e*) Position of guns and type of gun mounting. The gun mounting is always a snag in production. They are usually complicated and all not easy to make. One reason why they are complicated is because they must be splash proof, for the gunner will be behind the gun, and it is desirable to stop everything as far as possible getting through to him. Traverse is easy, as the whole turret is rotated, but for elevation the gun has to go up and down and so there must be a hole to allow for this movement. This hole must be made bullet proof.

The next move as a rule is to give the general arrangement drawings to a firm, and get them to make a pilot model. This firm will then become the "mother" of this particular tank. They have the job of detail design. As you may imagine, the selection of this firm is very important. It is up to them, working in conjunction with the C.S. of D. and the Ministry's Mechanisation Board, who act as consulting engineers, to produce the pilot model and all detailed drawings so that if the tank is approved it can go straight into production.

While the pilot model is being constructed, it is often decided to have a wooden mock-up made of the body. The main object of this procedure is to enable all concerned to decide upon stowage, straighten out any point from the gunnery point of view, fitting of wireless, &c. If all these points are cleared up at an early stage, it prevents modifications and alterations to the production models and final drawings. It also helps with plate design.

The problems involved in this procedure are many. It must be remembered that the Government's policy of disarmament has meant that until 1936 large scale tank production was non-existent. Firms require educating in this type of work. For the larger types of tank, all the bits and pieces have got to be special as nothing in the commercial world is comparable. For armoured cars a commercial chassis has been tried several times, but it has always been found that it is not satisfactory, as the work the vehicle is called upon to do is totally different to normal work. Perhaps the only exception is the Rolls Royce which came into the Service in 1922, and is still going strong in Egypt to-day.

The erecting firm is the main contractor; certain articles are made free issues, but it is preferable to keep them down to a minimum. The erector should sub-contract, and can then progress the work himself. He is in the best position to know when he wants each particular article. Free issues are always a source of trouble as the Ministry is the third party, and has to ensure the articles arrive when the erector wants them, and also they are responsible for the articles being as desired by the erector. This arrangement throws considerable work on both the Inspection and Progress Branches.

When the pilot model is received, it then has to go through all its tests. They include the performance requirements of the G.S. gunnery tests and a complete test of all the components to see if there are any weak links. The normal test is some 10,000 miles of mixed country, *i.e.* road and cross-country.

From the time the General Staff Specification is received, until the pilot model is running, is a considerable time. It must be remembered all the bits and pieces are "one-off" jobs. Firms naturally cannot afford to give undivided attention to work of this nature in peace time.

By reason of the length of time that elapses, there are serious dangers to be faced; considerable alterations will probably be asked for. The General Staff may decide that the situation has altered; someone has developed a wonderful new engine, the suspension is good, but would be so much better if this or that new idea is incorporated. It is perfectly obvious that unless a very strong hand is taken the tank will be completely altered. The only logical thing to do would be to build another pilot model if fundamental alterations have been made, as the tests would mean nothing. It is essential to realise fully that with tank production there must be long-term planning, and the tank which fulfils the original specification must be accepted, otherwise production troubles, delays, and failures in service, may occur.

If the whole tank proves satisfactory, then all is ready to go into production. The numbers required is the first question to be settled, the number the Treasury will permit is the next, and bigger trouble; then whether there is any bottle-neck in production, and whether this bottle-neck can be opened out; if not, then this is the limiting factor on numbers that can be produced. say, per month. Can one erector handle the job? Probably not, so others must be found. It is an unsound policy anyway to have all the eggs in one basket.

Before the first tank comes out there is an immense amount of work to be done; jigs are required, working drawings, labour trained, and the whole job planned from start to finish.

It must be borne in mind that tanks are special vehicles; there is absolutely no demand except from the Armies of the world, therefore there are no tank firms. There is a lot in this statement, as a firm has to try to exist at the end of a war and is therefore often unduly anxious not to loose any of its normal commercial trade, or it will be completely out of work once the war ends. This is a short-sighted view for they forget that if the war ends the wrong way there will be no trade for them anyway. Tank building is not everybody's meat; it is a complicated structure and only certain firms are in a position to accept the work. It is a heavy engineer's job, and most of the motor manufacturers are not suitable for the heavier type of tanks. They undoubtedly can do a lot of the sub-contracting and can handle the lighter work.

War Time Lighting

WE recently attended at the Lighting Service Bureau of the Electric Lamp Manufacturers Association of Great Britain at 2, Savoy Hill, London, W.C.2, a demonstration of war time lighting. Manufacturers and others interested in the problem of maintaining the adequate illumination in workshops, &c., under "black-out" conditions should find the investigations undertaken by this organisation a valuable help. A system known as the complementary colour system compromises between the totally blacked-out interior and that in which screens can be removed during the day. In accordance with this system windows are treated with a special blue varnish and the lamps employed can either be sodium discharge lamps with a special jacket where there is an A.C. supply, or tungsten lamps with a special glass envelope with a D.C. supply. During the day-time the varnished windows admit some 15 per cent. of daylight, while at night high intensity lighting can be employed without fear of being seen from the air.

Although war time lighting restrictions do not provide for any exterior illumination for factories, for work of National importance special permits may be issued for low intensity lighting. Extra low intensity lighting giving 0·002 foot-candle at ground level can be provided by a special fitting constructed to B.S. ARP/16. The fitting comprises a small reflector and cup to fit over the bottom of a 15-watt lamp. Allowances are made for mounting height by varying the colour of the interior of the reflector. A similar fitting constructed to B.S. ARP/20 and fitted with a 100-watt lamp is designed to provide 0·02 foot-candle. Spacing to mounting height ratio must not be less than 4–1 and, when installing a scheme for approval, care must be taken that the fittings are well clear of walls or other surfaces which may be illuminated to a greater degree than the illumination at ground level.

Considerable attention has been paid by the Association to light locks for doorways, ventilators, &c. In a large factory it is essential that light locks at main exits should be as simple as possible to allow quick and easy transit. The most simple method has been found to be to build a wall opposite the exit at least five times the width of the opening and roofed at not less than 7ft. In order that all light may be absorbed the wall, roof, and floor should be painted black.

For hand-trucks that have to be wheeled from one building to another a light-trap fitted with swing doors at both ends gives a satisfactory solution, as the truck can push the first door open and, provided a reasonable space is allowed before reaching the outer doors, the first set will have automatically closed. A similar device, but with hand-operated doors, can be used for lorries. Light locks with fluorescent signs and ventilator light locks have also been designed.

For precision work high intensity often calls for special lighting. The trough type of fitting provides a high level of diffused light superior to the ordinary local lighting. Benches near the walls can be illuminated to a high level by means of light projected on to the walls. Both these methods provide an excellent diffused light, particularly suited to the inspection of highly polished parts, for the reading of scales, or the assembly of small parts. For the illumination of large areas with good diffused lighting a mixed lighting unit comprising mercury discharge and tungsten lamps enclosed in an industrial diffusing reflector gives a good degree of colour correction and provides a greater light output for the same wattage of tungsten lamps. Whatever form of local lighting is used it should only be supplementary to the general overhead lighting and the ratio should not be greater than 10 to 1, and if economically possible it will be found better to keep it within a 5 to 1 ratio.

With the outbreak of war the use of blue lamps in certain public places is considered to have been a mistake, as except for decorative purposes this form of lighting was long ago discounted.

The psychological and physical benefits of good lighting, the Association points out, are enormous, and by providing a satisfactory black-out it is possible to maintain good seeing conditions. With a really good black-out there is not the least need to curtail normal lighting.

Rail and Road

NEW RAILWAY EQUIPMENT IN AMERICA.—During the first ten months of this year, the Class 1 railways in the United States put into service 17,417 new freight cars, 196 new electric and oil-electric locomotives, and 73 new steam locomotives, according to statistics of the Association of American Railroads. At the beginning of November, there were on order 28,931 freight cars, 72 electric and oil-electric locomotives, and 64 steam locomotives.

PRODUCER GAS FOR TRANSPORT.—At a conference held by the National Industrial Development Council of Wales and Monmouthshire, a committee was formed to encourage the production of producer-gas units and vehicles in South Wales. At the conference it was pointed out that if 50 per cent. of the heavy goods and passenger vehicles in Great Britain were run on producer gas, over three and a half million tons of Welsh anthracite would be used, and employment would be given to another 16,000 miners.

RAILWAYMEN'S INCREASED WAGES CLAIM.—A claim has been presented to the Railway Executive Committee by the National Union of Railwaymen for an increase of wages of 10s. per week. A statement issued by the Union criticises the delay on the part of the railway companies in making known their decision in regard to the recent awards of the Railway Staff National Tribunal. A majority finding of that body, issued on October 18th last, was for a minimum rate for male adult workers of 47s. in rural, 48s. in industrial, and 50s. per week in London areas.

LOCOMOTIVE RESEARCH IN AMERICA.—At the annual meeting of the Association of American Railroads, the research programme for the coming year was announced. It covered a wide range of activities, one of the most important being research work on proposed improvements in steam locomotive construction in order to increase the speed and power without a proportionate increase in weight or in the use of fuel. Among the matters to be considered will be the development of specifications for a steam locomotive designed to haul a train of approximately standard passenger coaches at a sustained speed of 100 miles an hour.

BRITISH MOTOR EXPORTS.—The President of the Society of Motor Manufacturers and Traders, Mr. E. W. Rootes, has officially stated that this country's motor industry will continue to supply the demands of overseas markets. This decision was reached after a series of conferences between representatives of the industry, and those of the Board of Trade, Department of Overseas Trade and Materials Controllers of the Ministry of Supply. In making the announcement, Mr. Rootes went on to say that although this imposes a considerable financial strain on British motor manufacturers by the production of vehicles for export without the support of a normal home demand, the burden is accepted as a necessity based on national and overseas interests.

LIGHTED SUBURBAN TRAINS.—The first interior-lighted steam suburban trains to be introduced on the London, Midland and Scottish Railway Company's services using St. Pancras, Broad Street, and Fenchurch Street stations, have been placed in service. On the Southend line, these trains are the 3.35 p.m. Southend to St. Pancras and 6.45 p.m. return; the 5.4 p.m. Shoeburyness to Fenchurch Street, 6.8 p.m. (Saturdays excepted) Fenchurch Street to Thorpe Bay, and 6.53 p.m. (also Saturdays excepted) Fenchurch Street to Shoeburyness. On the suburban section of the St. Pancras main line, the 4.35 p.m. St. Pancras to Bedford and 7.40 p.m. return are the first trains scheduled for reading-light equipment, whilst on the Broad Street service, the first train is the 5.24 p.m. (Saturdays excepted) to Tring.

THE CROSS DROVE LEVEL CROSSING ACCIDENT.—The result has been published of the inquiry into the accident which occurred at about 12.10 p.m. on June 1st, at Cross Drove Occupation level crossing, adjacent to Hilgay Station, on the Ely-King's Lynn line of the London and North Eastern Railway. The 11.2 a.m. up express passenger train, Hunstanton to Ely, was approaching the station under clear signals, at a speed of 60–65 m.p.h., when it collided with a lorry which was passing over the crossing; the lorry was wrecked and thrown foul of the down line, but one of the front wheels apparently became caught up under the engine, with the result that its bogie was immediately derailed. One bogie wheel thus struck the V of the obtuse crossing of the diamond, 57 yds. ahead of the level crossing, and complete derailment of the engine and train followed, resulting in collision between, and wreckage of, the leading coaches and certain wagons which were standing in the neighbouring siding. Colonel Mount came to the conclusion that the accident was solely attributable to the driver of the lorry who did not exercise reasonable caution in driving over the level crossing.

THE USE OF ELECTRIC STEELS.—In a paper by Mr. H. A. Sieveking, issued by the Institution of Electrical Engineers, it is suggested that the greatest possibility for extending the use of electric steels, apart from the somewhat limited field of special alloy steels, lies in the production of structural sections and plates, where the uniform crystalline formation will show to the greatest advantage. The author calculates that if of the total quantity of steel made in Great Britain only "sections" (35·8 per cent.) and "plates" (16·8 per cent.) were to be produced electrically, then two million tons per annum could be made in 60 furnaces of from 30 to 35 tons. Each would consume nine million kWh per year, with a maximum demand of 3000 kW, at an average price of 0·49d. per kWh. Diversity is ignored and under good conditions a load factor of 35 per cent. could be reached. Thus, if an average selling price of £11 per ton be assumed for this class of steel, the new product would require to be sold at £14·2 per ton. The reduction in total weight due to lower factors of safety would reduce the selling price to £11 again if the reduction were to 77½ per cent. of the present values—a very conservative allowance which would be accompanied by other savings, such as on freight to site, lighter foundations, and greater ease of handling generally.

Miscellanea

DISPLAY OF SAMPLE MUNITIONS.—On Tuesday, December 5th, The Minister of Supply opened in London at Savoy Hill House, W.C.2, a display of munition stores which has been arranged to assist firms prepared to undertake contracts. Similar exhibitions are open at a number of the larger provincial towns throughout the country.

FORT PECK DAM.—At the beginning of last month the pumping of the hydraulic fill at Fort Peck Dam, on the Missouri River, was completed. For this fill two dredgers have pumped over 122 million cubic yards of material, at times through 6½ miles of 28in. diameter pipe line over a lift of 228ft. with the aid of eight booster pumps. When completed the dam will be 250ft. in height and 9000ft. long flanked by a dike 11,000ft. long. The project was described in detail in THE ENGINEER of April 16th and 23rd, 1937.

PAYMENT OF CIVIL DEFENCE VOLUNTEERS.—Arrangements have been made to refund the wages which may be lost by unpaid part time Civil Defence volunteers when called out on duty in the event of an air raid. Payment will only be made to workers who lose their wages and not to those who are in receipt of their ordinary salaries from their employers when called out for duty. Local authorities have been authorised to compensate volunteers for any loss of remunerative time actually incurred, up to a maximum, in respect of a working day, of 10s. for men and 7s. for women.

A BLACK PLATING PROCESS.—A new black plating process, introduced in the United States by E. I. du Pont de Nemours and Co., is known as the "Moly-Black" molybdenum-nickel electroplating process. It is said to produce a lustrous deep black electro-deposit and is based on a combination of molybdenum and nickel, available in plating salt form. It is applicable to bases of zinc, aluminium, iron, steel, tin and nickel. An unusual characteristic is its ability to plate directly over aluminium prepared only by cleaning in an alkaline bath. The process operates at a high rate of deposition at low current densities and the deposits are of low density with a maximum thickness of about 0·002in.

DIFFICULT TUNNEL WORK IN AMERICA.—On November 8th, the final barrier, separating the Manhattan and Queen's headings of both tubes of the Queen's Midtown Tunnel in New York, was blasted. Considerable difficulty has been experienced in the construction of this tunnel driving, much of the distance being through rock at the bottom and silt at the top of the heading. Each shield started in full face rock, entered partly rock and partly silt ground, then full face silt and then a rocky reef at the middle of the river. The twin tubes, 6414ft. and 6272ft. long respectively, were driven by four shields 31ft. 8in. diameter, two starting from each shore. The tunnel is being constructed at a cost of 58 million dollars.

STORING STRATEGIC MINERALS IN AMERICA.—In order to ensure an adequate supply of certain minerals, which the country does not produce in sufficient quantity, the United States Congress has authorised an expenditure of 100 million dollars on the purchase of stocks to be used in the event of a national emergency. It is expected that the minerals to be purchased will probably include manganese, chromite, tin, tungsten, antimony, quicksilver, and other metals. For the first year, only 10 million dollars have been appropriated, in order that domestic producers may be given a better opportunity to develop production, and to share in these purchases. At the same time Congress has authorised the expenditure of 500,000 dollars annually by the U.S. Bureau of Mines and the U.S. Geological Survey in searching for, developing, and determining suitable metallurgical treatment for domestic deposits of strategic minerals.

IMPROVING PILE FOUNDATIONS.—A note in the *Scientific American* says that recent investigations in pile foundations have developed an interesting method for increasing the bearing capacity of piles by covering them with a thin sheet of aluminium metal and sending an electric current through the soil. Preliminary small-scale tests performed revealed the formation of an entirely new and hardened soil structure in the vicinity of the electrodes. Tests also revealed that the hardening is not simply a drying of soil, but is irreversible since aluminium compounds are precipitated in the soil by the electrical process, cementing the mineral particles of the soil. Some timber piles 60ft. long covered up to about 25ft. with thin aluminium were driven between six and seven feet apart and electric current at between 90 and 220 volts was passed through the aluminium. It was found that the process had increased the bearing capacity from 70 to an average of 200 tons.

WORK HARDENING.—In a lecture to the Sheffield Metallurgical Association on Saturday, November 11th, Professor J. H. Andrew, D.Sc., said it is commonly thought that a carbon steel, on being drawn into wire, increased in hardness purely on account of the great distortion suffered by the iron. A steel in the soft condition is simply a mechanical mixture of the metal iron and a chemical compound, carbide of iron. Pure iron may be drawn into wire, so that it may attain a maximum strength of approximately 40 to 45 tons; but a steel having a sufficiently high carbon content may be drawn into piano wire so that its maximum strength may reach as much as 250 tons per square inch. There could only be one reason for the great strength of the steel as compared with the pure iron, namely, that the structure obtained by the drawing operation was similar to that obtained on hardening by quenching. He had been carrying out at the University experimental work, in co-operation with Mr. Hsun Lee, which seemed to prove this contention. This reasoning could be applied to the taking of a mechanical test. Up to the yield point the strength of the steel depended upon its original state, but as soon as the test-piece began to elongate, a chemical change occurred continuously as stretching proceeded, with the result that the fractured end of the test-piece was constitutionally very different from the original bar. This theory might be applied to explain the absence of any definite relation between the yield point and the maximum stress.

Air and Water

The Admiralty announces that on Tuesday, December 12th, a Fleet Air Arm aircraft collided with a balloon barrage cable and was destroyed with the loss of four lives.

SHIPYARD MEALTIMES.—In order to maintain the output of ships in the present shortened days, resulting from the blackout and other conditions, shipbuilders and ship repairers have agreed to cut the dinner period by half an hour and to finish at 4.30 p.m.

THE ELGAR SCHOLARSHIP.—The Institution of Naval Architects announces that the Elgar Scholarship in Naval Architecture will be offered for competition in 1940. This scholarship, valued at £130 a year, is tenable for three or four years at a selected university.

AEROPLANE CAPACITY OF AMERICA.—A survey of the Aeronautical Chamber of Commerce of America has shown that the aeroplane manufacturing industry of the United States has a production capacity of 1250 machines a month, and the factory space devoted to this class of work is being increased.

LIGHTING OF SHIPYARDS.—Replying to a question in the House of Commons, Sir John Anderson said that schemes of suitably screened lighting, to be extinguished on receipt of an air raid warning, have been devised for various industries, including shipbuilding, where essential outside work has to be done.

SHIPS ON JAPANESE EUROPEAN SERVICES.—It is reported that as a result of the loss of the 11,000-ton liner "Terukuni Maru," which sank after striking a mine off the East Coast of England last month, the N.Y.K. company has decided to replace the latest class ships it now employs on European routes by ships of 6000 or 7000 tons.

TYNE FERRY SERVICE.—A private company with a capital of £25,000 has been formed to take over the Hebburn-Wallsend and Walker ferry service of Robert Stephenson and Hawthorns, Ltd.; the new company has been formed by Swan, Hunter and Wigham Richardson, Ltd., Vickers-Armstrongs, Ltd., and A. Reyrolle and Co., Ltd.

TRINITY HOUSE PILOTAGE DISTRICTS.—An order relating to all Pilotage Districts under the jurisdiction of the Corporation of Trinity House, states that Trinity House may appoint Pilotage Committees consisting of such persons as it may think fit, whether Elder Brethren of Trinity House or not, and may delegate to such Pilotage Committees any of the powers or duties of Trinity House relating to pilotage matters.

PROPOSED SOVIET TRANS-ARCTIC SERVICE.—A Soviet scheme is in hand for the opening of a trans-Arctic steamship service from Nikolaevsk at the mouth of the Amur River, to Murmansk *via* Kamchatka and the Behring Straits. It is proposed to open the route in 1942, and with it the Far East will be brought within a distance of 6000 miles, as compared with 12,000 miles from the Far East to northernmost Europe *via* the Mediterranean.

On Tuesday last a British submarine reported that it had sighted the German liner "Bremen," which it will be recalled left New York about three days before the outbreak of war. She was not heard of until it became known some weeks later that she was in the Russian port of Murmansk. On Wednesday it was reported in this country that the ship had safely reached a German port. The "Bremen" has a gross tonnage of 51,000, and a speed of 30 knots.

PROPOSED AMERICAN LINERS.—It is reported from America that the United States Maritime Commission is shortly to order two luxury liners for the trans-Pacific trade. Since the Commission began its programme last year it has placed contracts for 141 ships, of which the 28th has been launched, and it is expected that seven more will be launched before the end of the year. It is estimated that the one and a half million tons of shipping ordered to date has cost over 345 million dollars.

PROPOSED IMPROVEMENT OF THE CLYDE CHANNEL.—The Clyde Lighthouses Trust has promoted a provisional order in which authority is sought to alter, deepen, and widen part of the River Clyde navigable channel. It is proposed to carry out the work at a part of the channel-way between Newark Castle, at the east end of Port Glasgow, and a point 350 yards or thereabouts from the outer north-western end of Prince's Pier, Greenock. The distance involved is between three and four miles.

LONDON SHIPPING.—According to the *P.L.A. Monthly*, the record figures of the Port of London for 1937 might have been closely approached or even exceeded but for the outbreak of war. Between January and June of this year 31,000,989 net register tons of shipping used the port, compared with 30,454,477 net register tons during the same period of 1938. Similarly, the comparable figures for the quantities of goods imported and exported were 21,488,935 tons and 21,397,708 tons for the first six months of 1939 and 1938 respectively.

LARGE WELDED TANKER.—What it is said will be the largest all-welded ship in the world has been ordered in the United States by the Atlantic Refining Company. The ship will have an overall length of 543ft. 10in. and a beam of 70ft. She will have turbo-electric propulsion engines designed to develop 5000 H.P. and to give a speed of 13½ knots. The capacity will be equivalent to over six and a half million gallons and the pumping equipment installed will enable cargo to be handled at a rate of 500,000 gallons an hour.

SEIZURE OF CONTRABAND.—The Allied contraband control has intercepted and detained about 735,000 tons of contraband since the outbreak of hostilities, it was announced on Wednesday, December 6th. This country had detained 476,500 tons of the total. During the week ended December 2nd, the British contraband control intercepted and detained 13,700 tons of contraband goods of which there was evidence that they were destined for Germany. This total included 4500 tons of iron pyrites, 1750 tons of hides and skins, 850 tons of timber, 500 tons of cotton, 400 tons of petroleum products, and 250 tons of chemicals.

RAILWAY SIGNALLING PRACTICE

(For description see page 582)

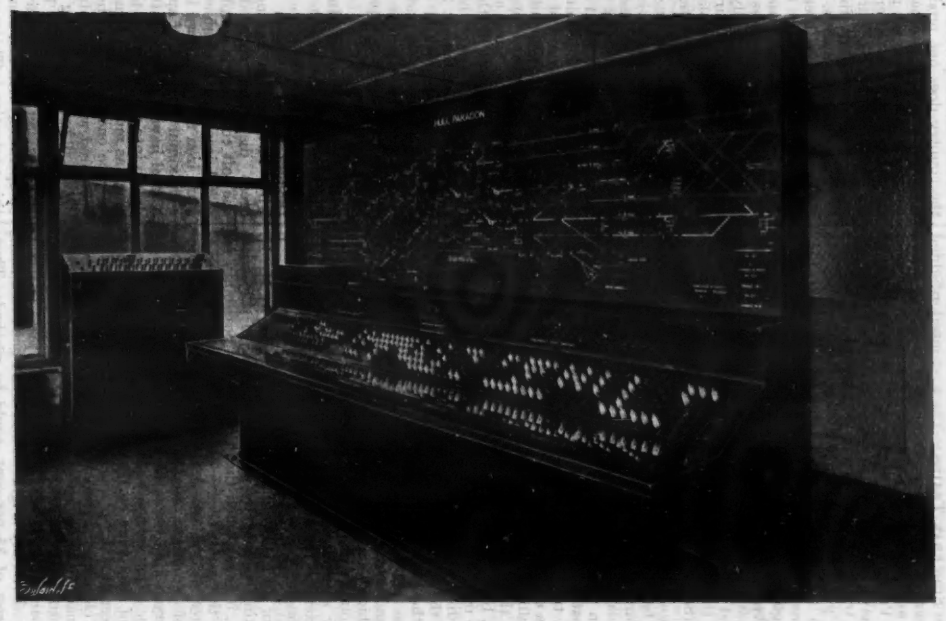

FIG. 14—HULL, PARAGON STATION, SIGNAL BOX, 1904-1938

FIG. 15—GLASGOW, ST. ENOCH STATION, ALL-ELECTRIC LOCKING FRAME

FIG. 16—HULL, PARAGON STATION, CONTROL PANEL WITH ROUTE SWITCHING

FIG. 17—CONTROL PANEL AND MECHANICAL POINT LEVERS

The Engineer

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Contents

THE ENGINEER, December 15th, 1939 PAGE

A SEVEN-DAY JOURNAL ... 581

LEADING ARTICLES—
THE WAR AT SEA—MINES ... 593
THE DILUTER IN ENGINEERING ... 594

SPECIAL ARTICLES—
MODERN RAILWAY SIGNALLING PRACTICE. No. II. (Illus.) 582
REMOTE SUPERVISORY CONTROL. No. VI. (Illus.) ... 586
SALVAGE OF U.S. SUBMARINE "SQUALUS." No. I. (Illus.) 584

ALUMINIUM ALLOYS AND THE MODERN STEAM ENGINE ... 597
AMERICAN ENGINEERING NEWS ... 598
ARC WELDER. (Illus.) ... 600
ARMY VEHICLE SUPPLIES 589
A.R.P. LIGHTING FITTING. (Illus.) ... 601
CENTRALISED CONTROL SYSTEM. (Illus.) ... 598
ELECTRIC FURNACE FOR BRIGHT HARDENING DIES. (Illus.) 600
FARJSUND BRIDGE, FINLAND. (Illus.) ... 589
FAST FIREBOAT. (Illus.) ... 599
GLASS FOR A.R.P. ... 601
JIG SAWING AND FILING MACHINE. (Illus.) ... 600
METAL MELTING FURNACE. (Illus.) ... 601
NEW VIBRATING SCREEN. (Illus.) ... 599
SUPER HIGH-SPEED PIN-HOLE CAMERA. (Illus.) ... 596
WAR-TIME LIGHTING ... 590

LITERATURE ... 594
SHORT NOTICES ... 595

OBITUARY—
ENG. CAPT. H. R. TEED ... 595
W. A. DEXTER ... 595
J. E. FLETCHER ... 595

NEWS AND NOTES—
AIR AND WATER ... 591
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 604
BRITISH STANDARDS INSTITUTION ... 601
CONTRACTS AND ORDERS ... 604
CURRENT PRICES FOR METALS AND FUELS ... 603
FORTHCOMING ENGAGEMENTS ... 604
FRENCH ENGINEERING NOTES ... 604
MARKETS, NOTES AND NEWS ... 602
MISCELLANEA ... 591
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 604
RAIL AND ROAD ... 591
SIXTY YEARS AGO ... 595

NOTICES TO READERS

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Copies of THE ENGINEER can be obtained at 28, Essex Street from Friday mornings.

PAPER SUPPLIES

With a view to the conservation of paper readers are advised, in the interests of all concerned, to place a regular order for "The Engineer" with their newsagent or direct with the Publisher.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

CHANGE OF ADDRESS

*** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address : "The Engineer," 28, Essex Street, Strand, London, W.C.2.

Telegraphic Address : "Engineer Newspaper, Estrand, London." Telephone : CENtral 6565 (10 lines).

THE WAR AT SEA—MINES

SINCE Mr. Churchill last reviewed the War at Sea on November 8th—see THE ENGINEER of November 17th—an important change in the methods of the enemy has taken place. Towards the end of October, Hitler had begun to threaten the allies with a secret weapon to which they could make no reply. It was widely assumed that he was preparing some new and horrible form of chemical warfare, but in the light of subsequent events it seems clear that what he had in mind was the indiscriminate use of the mine, with equal disregard of neutral and enemy shipping. He sought, and is seeking, by that means, to drive neutrals from the sea, to set them in opposition to the Allies, and to hamper the sea-borne commerce of Great Britain. The weapon is two edged. The Allies have replied, as they did in the Four Years War, by placing an embargo on all German exports in whatever bottoms they are carried, if more than twenty-five per cent. of the work is of German origin. That course must inevitably have severe economic effects in Germany, the incidence of which will increase cumulatively as the months pass. But of greater immediate importance is the success of the measures which are being taken to neutralise the attacks on the shipping of the Allies by the convoy system, the constant destruction of U-boats, and the application of extended and new methods of sweeping the sea of mines.

On all these matters, Mr. Churchill had a great deal of a cheering nature to report in the review of the war at sea which he gave in the House of Commons on December 6th. "The destruction of U-boats," he said, "is proceeding normally and in accordance with the estimate I gave to the House of between two and four a week. That is to say, at a rate superior to what we believe to be the German power of replacing U-boats and competently trained U-boat crews." The rate of destruction varies with the number at sea, which varies periodically. When it is at its summit, destruction is high, and it is believed by the Admiralty that no less than five were put down last week by the Navy and the R.A.F. But the risk of the enemy getting the better of our means of destruction is not being neglected. The number of hunting craft has been tripled since the war began, and "very great reinforcements" will come into service next year. Already one thousand ships have been armed to resist attack by U-boats, and another thousand are being provided with the appropriate weapons. Mr. Churchill added that "The efficacy of the asdic method of detection is increasingly proved, and as our margin in hunting craft increases, as it has done and will do rapidly, the ordeal to which the U-boat is subjected will become even more severe." It may be useful to our readers if we say that asdic is the official name for the Admiralty's own development of the sound detector which has been in use in various forms for many years.

On the indiscriminate sowing of mines by submarines and sea planes much has been said in anger and indignation, and not a little about the psychological folly of a course which is annihilating the last fractions of sympathy which neutrals may have had with Germany. But Germany—or should we say Prussia in this connection?—has never shown the slightest tendency to consider or even to understand the psychology of other peoples. That arrogance and superciliousness has led her into great troubles before, and will do so again. What is happening already, and what will happen to a greater extent, is that neutrals are chartering their ships to Great Britain for the duration of the war, so that they may enjoy the very effective protection of our convoy system, receive higher profits than they ever made in peace, and have a complete guarantee against loss. The convoy system is not effective against submarines alone but, under Admiralty directions, the danger from mines is enormously diminished. Less than one ship out of every 750 convoyed has been sunk. Mr. Churchill reported that "the losses of British merchant ships in October were half what they were in September, and in November they were only two-thirds of what they were in October." This despite the fact that sea-borne traffic has not been appreciably diminished. The fate of neutrals has been far different. They have suffered severely from German mines. "More than half our losses in the last month have been due to the magnetic mine, but two-thirds of the total losses from the use of this mine have fallen, not upon belligerents, but upon neutrals."

There is a good deal of popular misconception about the magnetic mine, and we feel some regret that no official description of it, and its limitations, has been published. Mr. Churchill said very rightly that it is neither new nor mysterious, its secrets are already known, and before the first was laid, by submarine or aeroplane, counter measures were already far advanced. It may be said at once that the magnetic mine has none of the prowling properties attributed to it by some persons. It does not wander about the sea seeking for its prey; it is not drawn towards ships by magnetic attraction. It is magnetic only in the sense that it is fired by magnetic induction or by the pull of a steel ship on a carefully poised magnetic trigger. Unless it differs very greatly from those produced twenty-five years ago in this country and America it rests upon the bottom, and is made of a cheap non-magnetic material. Hence it is only effective in shallow water, like the Thames Estuary. The larger the ship, the more likely it is to start the mine, not because it has a greater volume of steel, but because being of greater draught it is nearer to the mine. Since the induction varies inversely as the square of the distance doubling the draught may quadruple the action in shallow waters. Moreover, the greater the draught the nearer the ship's bottom is to the explosive. All these things are obvious to engineers, but there are many details concerning the mines about which they are kept in what seems to us to be unnecessary and even undesirable ignorance. With the greatest deference to the naval and scientific experts who are investigating the problem, we cannot but feel that a complete revelation of all the facts as far as they are known, might enable some scientist or engineer to propose a more effective method of dealing with the menace than has yet been devised. It would, moreover, have, perhaps, the not undesirable effect of reducing the number of suggestions based on incomplete knowledge which are sent in daily to the Admiralty.

Despite the ruthless and illegal laying of unnotified minefields, and the attacks of submarines without word of warning, the total loss of ships of the British Mercantile Marine has amounted in three months of war to no more than 340,000 tons, out of a total tonnage, large and small, of 21,000,000 tons or not much more than 1½ per cent. On the opposite side of the account we have increased our mercantile marine by transference, by prizes, and by new vessels by 280,000 tons leaving a net loss of 60,000 tons, or about one-third of one per cent. "We should," said Mr. Churchill "have to go back to the Hundred Years War to provide sufficient time and scope for inroads of this degree to make any serious impression upon our mercantile marine." Last month nearly a quarter of a million tons of shipping entered or cleared from our harbours for every 1000 tons lost. Such figures as these would convince the German people, if they could be made acquainted with them, that the war at sea is going against them. Germany has gained nothing by her piratical methods. Here, in this island, dependant upon the sea for its maintenance, the depletion of the supply of oversea commodities has taken place at such a slow rate as to be inappreciable. We live much as we have always lived, and rationing has not yet begun. We owe that to the indomitable spirit of the Navy, the Air Force, and to the fishermen and sailors of our land who, despite dangers and prolonged anxiety, have refused to be deflected from their duties by the sea threat. We owe it to their women folk, who have borne patiently and courageously weary days and nights of anxious waiting, and the grief of great losses. And we owe it to the policy and resolution of Parliament which in all things has supported and encouraged the

Government in its determination that the sea tradition of this Kingdom shall be sustained at whatever cost, and that a mad menace to the sea commerce of the world shall not prevail.

The Dilutee in Engineering

The doctor legitimately objects to the dispensing chemist prescribing for the sick patient, and in the same manner the skilled mechanic may be forgiven for disliking "dilution" in his sphere. It is accordingly greatly to the credit of those excellent craftsmen, who are the recognised backbone of the industry of the country, that they are ready in days of adversity to help the unskilled worker to become proficient in those operations which he can tackle, and so make his contribution towards that vast manufacture that is essential to meet war requirements. Nevertheless the best will in the world will not solve the problem unless accompanied by careful organisation, training, and systematic common sense.

It would obviously be impossible to expect the unskilled worker to operate one of the highly specialised machine tools of the present day, and the task for the management is to resolve a complex set of operations into a number of simpler ones which can be entrusted to the raw recruit after a brief period of training. Fortunately, the development of a mass production mentality in peace time has eased the difficulties of armament mass production. But even if it were decided to go to the extreme, and only have a single operation on each machine tool, there would still remain the trouble of gauging the work, and keeping an intelligent eye on both cutting tool and material on which the work was being performed. There must ever remain the human element. Accordingly it is essential that the few skilled men, whether tool setters or instructors, should have a capacity for appreciating the outlook of the novice, and of giving encouraging help or advice at the right time, and all with a judicious leavening of tact. With the best instruction on the one hand, and with the highest degree of keenness on the part of the tyro, it must be frankly admitted that the work of most dilutees is soul destroying. Few with any imagination could face with equanimity the thought of spending every day, hour by hour, on one single operation, but the work has to be done. The manager who has a knowledge of psychology will be at a distinct advantage; he will realise the limitations of the worker, will contrive initially to select those best suited to the work, and he will then proceed to give them an interest in life. Female labour is generally admitted to be better on simple repetition work than male labour; the boy is always anxious for better work, for prospects of advancement, and for an avenue of escape from a blind alley, while the girl's desire is to ensure maximum earnings while the going is good. Maybe she has in a way more imagination and can give her mind free play, while her fingers are accurately and actively employed. The extent to which the supply of female labour will be reduced by A.R.P. and other war efforts remains to be seen, but whoever the dilutee is, it is essential that interest be maintained, and team spirit fostered. Interest can be developed in more ways than one; by taking all the operators into the confidence of the management and showing the importance of each activity and the disastrous results of the failure of one human being to fulfil his or her role, a desire will be encouraged to be numbered among those who never "let down" the show; again the display in a prominent position in the workshop of the weekly production of each unit against a predetermined bogey helps to develop that spirit of friendly rivalry which is instinctive in most Englishmen; but above all the wise management will evidence the keenest solicitude for the happiness and well-being of those entrusted to its care, not by so-called "welfare work" but rather by giving the best working conditions possible, and ensuring regular and recognised rest periods, while being prepared at all times to enter into any social activities that may be arranged, without seeking to direct them. The fostering of a family spirit in the works will do more to inspire the efforts of the dilutee than the so-called "scientific" urges advanced by the efficiency expert.

To take a practical example: a managing director boasted that he could take a youth straight from the fields and in half a day have him operating a machine that is usually regarded as more complex than those normally associated with schemes of dilution. He did it, but he had taken off his coat, operated the machine himself, and explained its potentialities to the admiring youth, and then initiated him into the mysteries of handling the machine tool for himself. A manager who adopted an aloof attitude could never have accomplished this. In the fitting and erecting shop the problem of dilution is more difficult, for the dilutee is somewhat scared by the prospect, but with efficiently organised machining fitting should be reduced to a minimum, and by breaking down assembly to components and single operations a novice can accomplish much. Rifle making was once considered one of the most highly skilled trades in the country, to-day it has been reduced to a mass production basis, with the fitter conspicuous by his absence, and interchangeability of parts to a degree undreamed of a few years ago is now an accomplished fact. What has been done in the case of one article can be done in many another. Having said all this, the skilled man must ever have his place in industry, be it in the tool room, or as instructor, machine setter, or demonstrator, not to mention the many spheres of supervision which would not be called for in an undiluted market. The more he encourages his lower brother, and the more production is increased, the greater will be the scope for his energies. And, finally, co-operation and an attitude of friendly understanding and helpfulness will do far more to obtain results from the dilutee than all the formulas and shibboleths conceivable.

Literature

Factory Costing and Organisation. By H. H. Emsley, B.Sc., and J. Loxham, A.M.I. Mech. E. London: Constable and Co., Ltd. 1939. Price 9s. net.

This book is a revised and enlarged edition of Mr. Emsley's *Factory Costing*, which appeared in 1924, but has now been enlarged and re-written with the collaboration of Mr. Loxham. It is an excellent text-book for students approaching an important subject, with only a general engineering training. While primarily applicable to instrument making it clearly sets out the general principles pertaining to most industrial undertakings. The great value of a modern costing system is the manner in which it can throw a flood of light on each individual item of expenditure, which could otherwise only be guessed, and so the management is enabled to take appropriate action at the right time and in the proper way.

The work is now divided into three parts, the first being concerned with resolving the cost of a manufactured article into its elements, and the methods of dealing with them are explained. In Part II the organisation of a modern works is usefully reviewed, and the many functions of the different auxiliary departments are explored. Part III is devoted to a consideration of the costing system, showing how it is applied, and its usefulness to the management, as well as being an aid to sound estimating, without which no modern undertaking can hope to function in an efficient manner. A chapter is devoted to the one-man business and small establishment, a subject which is too frequently overlooked, but yet such businesses can benefit greatly by a satisfactory costing department.

The many systems of remunerating labour are set out very fairly, but we feel the authors might have developed some of the inherent weaknesses of premium systems, which have led to the opposition of trade unions, and to their unpopularity in this country. While handling the important subject of factory expense the different recognised means of recovering the oncost are discussed, but perhaps the reader is left somewhat in the dark as to which is considered the most reliable, although admittedly we read that "granted . . . the management is sincere in its desire to obtain accuracy in costing, the hourly rate method should be adopted wherever possible, and so arranged that the host of idle time is clearly shown-up." We agree, but suggest that all other sources of loss should similarly be "shown up," and it is felt that when the machine-hour-rate has been decided upon, it should be fully applied. We should prefer to see the authors group machines of equal significance from the costing point of view, rather than all lathes being put in one group, all milling machines in another, and so on. Such grouping may lead to serious mistakes in the results obtained. Even after the machine-hour-rates have been carefully determined it is necessary to watch them closely, and revise them from time to time to ensure their presenting as truthful a picture as possible.

When the authors speak of the reconciliation of financial and cost accounts, they seem to imply a discrepancy between them, a state of affairs which should be deprecated, as both are intended to speak the truth, but from different angles; in other words, the two accounts should be interlocked.

We cannot understand why the bulk of the section devoted to factory organisation should be printed in smaller type, seeing that the subject discussed is one of equal value with the rest of the book, indeed, it gives the student a very good idea of the subject in a way that should enable him to pursue it subsequently, and follow it up in far greater detail.

We fully agree with the contention of the authors that the desiderata of a costing system are accuracy, a *sine qua non*, intelligent assistance to the works management, as also to the estimating department, which must ever maintain close contact with the costing office, and at the same time a simplicity which will commend itself to all who come in touch with the department. We are strongly of opinion that the role of cost accountant should be that of handmaid to the works management, but should never assume to be its master.

Among the specially useful features of this book might be mentioned the selection of typical forms with which the book is illustrated, and which should help a student readily to understand simple costing; also the way in which the value of graphical charts and diagrams is demonstrated; and finally the number of suggestive questions at the end of each chapter, to which answers are given for the first time, which should prove a definite asset to the student who is working alone.

In all books intended primarily for the use of students a carefully selected bibliography is most helpful; one appeared in the former book and it might well have been incorporated in the present one, but brought up to date by the inclusion of a number of valuable books that have been written in recent years. At the same time it seems quite unnecessary to include in the appendix tables of logarithms and anti-logarithms.

Although at first glance we may have appeared to be rather critical of this book, we have actually only desired to bring a different outlook on a few points for the consideration of author and reader alike, and we are ready to recommend it to the engineering student as a book written in a language he can readily understand, simply and clearly set before him, and it should also prove helpful to works managers and foremen who are anxious to master the fundamentals of cost accounting.

The Locomotive Running Department. By John G. B. Sams. London: The Locomotive Publishing Co., Ltd. 1939. Price 3s. 6d.

This little book forms an addition to locomotive and railway literature which will be heartily welcomed by the "Students, Aspirants, and others" to whom the author addresses it. It is often said that "those who know cannot write." That is sometimes true, but not in this case. The attraction of this short treatise lies in the fact that the author is an experienced locomotive and railway man, that he has quite clearly defined views on the duties and equipment of Locomotive Running Departments, and that he expresses himself with straightforward simplicity. It is not a text-book. Mr. Sams does not go into minutiæ, but he says enough about the subjects with which he deals to put his readers right on principles.

He opens with an interesting discussion on depots and their management, taking as an example the Nairobi Running Shed of the Kenya and Uganda Railway of which he was Locomotive Superintendent for some years. Then there is an admirable chapter on Plant, in which the essential equipment of running sheds, and its proper use, is described. We could have wished for a few cross headings here as the reader hops from one subject to another without a word of warning, and there is no index.

In the third chapter, Mr. Sams deals with engine workings. This is a chapter that critics of railway operation ought to digest. We have found over and over again that few people are able to appreciate the difficulties that beset the drafting of railway time tables. Our author presents a review of the subject which without going into all its intricacies gives an excellent outline of the arrangements that must be made for the movements of engines. His remarks may profitably be read in conjunction with Chapter Seven, the last in the volume, which deals with Operation.

The intermediate chapters are devoted to Store Keeping; Failures, Routine Examinations, and Attentions; and Breakdowns. In all of them Mr. Sams speaks as one having long practical experience of his subject and his advice is invariably sound and inspired by common sense.

SHORT NOTICES

A Practical Manual of Chemical Engineering. By H. Tongue, M.I.Mech.E. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 36s. net.—This book is based upon notes in connection with the design and construction of chemical process plant, which have been systematically collected by the author for the past twenty years. It is pointed out that no attempt has been made to deal exhaustively with the whole field of chemical engineering, but what are generally regarded as the most important aspects of the work of the chemical engineer are thoroughly covered. Each section is introduced by a short discussion of the fundamental principles of design followed by references to relevant practical designs and formulae. The early chapters are concerned with various metals, their properties, working, and applications, followed by descriptions of non-metallic materials of construction. Later chapters deal with the apparatus and plant commonly used in chemical engineering. The various sections describe pressure vessels, pipes and pipe work, heat insulation, steam plant, evaporators, drying, adsorption, distillation, filtration, crushing and grinding equipment, and chemical works pumping. The text is supplemented with illustrations, drawings, and charts. As a reference work for chemical engineers and students the book is a valuable addition to literature on the subject.

Obituary

ENGINEER CAPTAIN H. R. TEED, R.N. (Ret.)

AN APPRECIATION

J. A. R. writes:—

As a lifelong friend of the late Engineer Captain Henry Richard Teed, who passed away on November 28th, and as one of the older generation of Naval Engineers, now, alas, sadly dwindling, I should like to pay a tribute to "Billy" as he was affectionately called by his intimates.

We entered Keyham together on July 1st, 1880, and were of the hundred who stepped over its portals when the College was first opened. He followed the ordinary career at sea in various of H.M. Ships, including the "Swiftsure," flagship of Sir Algernon Heneage on the Pacific station, and the "Partridge," gunboat on the North American station. In the latter ship he well remembered the present Premier and his activities in the West Indies in connection with the cultivation of sisal.

As these notes are made from memory, the writer is somewhat nebulous as regards dates, but one of the chief claims which Teed might make in the advancement of Naval Engineering occurred when he was Overseer in the Birmingham District at the beginning of the present century (about 1902), when he introduced into the Admiralty specifications many modifications in connection with the manufacture of condenser tubes, such as machining the castings inside and out before drawing. It must be confessed that some of these changes did not meet with the approbation of the manufacturers, but certainly some of the greatest improvements as regards freedom from defects and longevity of the tubes are due to innovations introduced by Teed.

Then later, about 1906, when he was Engineer Commander in the Cruiser "Cochrane" in the Fifth Cruiser Squadron this ship was a by-word for speed and economy. Certainly, she always went off by herself to do her speed trials, but Teed's veracity was always beyond reproach. His order book, too, in that ship was a classic, and copied by many of his confreres, and is still spoken of with awe by some of the Junior Officers who served under him.

During the Great War, when he was due for retirement, he was called up and served as Overseer for some years at Sheffield and again showed his great ability in mastering steel works practice. Though he was always looked upon as somewhat of a martinet, yet he was aware that his role was to help the manufacturers in every possible way. He was the more able to do this as he always mastered the details of the subject with which he was dealing. Afterwards he was on the staff of the Director of Naval Equipment at the Admiralty, and introduced many improvements in the Salvage Service. His assistance to our American Allies was recognised by the bestowal of the Medal for Distinguished Naval Service.

After the Armistice, he became Chief of the London Office of W. H. Allen and Sons, Bedford, and only retired from that position at the beginning of this year.

He was a true friend, and though perhaps he did not always suffer fools gladly, yet he was generous to a fault, and of the best type of Naval Officer. A die-hard of the die-hards, he will be sadly missed by his old Service friends and by the Members of St. Stephen's Club.

WILLIAM ALLISON DEXTER

POWER station engineers and users of condensing plant will learn with deep regret of the death, at his home, Shields Road, Pollokshields, Glasgow, on Sunday, December 3rd, of Mr. William Allison Dexter, Director of the Mirrlees Watson Company, Ltd., who was associated with the condensing department of the firm for over thirty-seven years. Mr. Dexter, who was sixty-eight years of age, was born in Bradford, and received his education at the Bradford Technical College. On completing his engineering education in 1889, he joined the firm of James Leening and Sons of Bradford, where he was engaged on drawing office work connected with tools and jigs used in the manufacture of textile machinery. In 1890 he joined the firm of Cole Marchant and Morley, where he gained further drawing office experience on the design of steam engines and mill gearing; after two years with that firm he spent a further two years with Rose, Downs and Thompson of Hull, returning to Cole Marchant and Morley in 1894. In the position of leading draughtsman, on Corliss engine work and condensing plant, he first met his friend, Mr. Charles Day, with whom he was so closely associated during the whole of his subsequent career. Following Mr. Day he joined the firm of Ferranti of Hollinwood, and was engaged for three years on steam engine work from 1899 to 1902. In that year he again followed Mr. Charles Day, and was appointed to the staff of the Mirrlees Watson Company of Glasgow, as manager of the condensing plant department. When he joined the firm, Edwards' reciprocating air pumps were almost universally used, and he produced an excellent design of pump, many of which are to-day doing good service. Mr. Dexter was one of the first to recognise that with the increasing size of power station and industrial units, the days of the reciprocating pump, for such work, were drawing to a close. The firm adopted the Leblanc rotary air pump, which was later followed by the now universally used steam ejector. In the development and application of both types of air pump, Mr. Dexter played a leading part. In this connection he read several papers on condensing plant before the Manchester Association of Engineers, the Institution of Engineers and Shipbuilders in Scotland, and the Institute of Marine Engineers. For many years he did valuable work on the Council of the British and Electrical Allied Manufacturers Association. He was a member of the Institution of Mechanical Engineers, the Institution of Engineers and Shipbuilders in Scotland, and the Institute of Metals and of the Corrosion Committee of the British Electrical Industries Research Association. In 1913 he was made a director of the Mirrlees Watson Company, and later became a director of Mirrlees Bickerton and Day, Ltd. His bright and cheerful disposition made for him many friends who will deeply deplore his loss.

MR. J. E. FLETCHER

WE announce, with regret, the death at Dudley in his seventy-second year of Mr. J. E. Fletcher. He was born at Chesterfield and educated in Sheffield. His apprenticeship was served in the works of the Clay Cross Company, and he became Foundry Manager and later Works Manager in the steel works of Thos. Firth and Sons and Cammell, Laird and Co. In 1905 he was appointed Chief Engineer to N. Hingley and Sons, Netherton, and later became their Consulting Metallurgical Engineer. He was an original member of the Council of the British Cast Iron Research Association, and later became Consultant to the Association, particularly on melting practice. In that capacity he carried out the experimental work and evolved the design of the type of cupola furnace which he patented jointly with the British Cast Iron Research Association and which became known as the balanced blast cupola, over two hundred installations of which have been made in this country and abroad. He was a Past President of the Staffordshire Iron and Steel Institute, and a member of the Institution of Mechanical Engineers, by which body he was awarded the Bernard T. Hall prize in 1926 and was responsible for many technical contributions to various institutions, including the Iron and Steel Institute. He travelled extensively on the Continent and in America in connection with his business and scientific activities.

Sixty Years Ago

JAMES R. NAPIER

IN our more exalted periods we pride ourselves with the thought that we could have done all that Watt and Stephenson did if unkind fate had not compelled the date of our birth to follow instead of precede theirs. In the history of invention and discovery a fortunate birthday has more than once been the road to fame. Equally, and perhaps even more frequently, genius is born after its time, and the fame which should have been its due is denied it. Although we would hesitate to describe James R. Napier as a "mute inglorious Milton," there can be no doubt that had he been the father instead of the son of Robert Napier of Shandon his name to-day would have been more famous than that of his famous parent. He died on December 13th, 1879, in the fifty-ninth year of his life. No great distinction came his way; the mantle of his father and of other great men fell heavily upon him and encumbered him throughout his career. Naturally he began in his father's yard. In his early life he seems to have made an effort to cut himself adrift from the influence of his heritage. In conjunction with Thomas Hoey he set up in business on his own account as a shipbuilder at Govan. Had Hoey been a Boulton he would have found in James Napier one well fitted to reproduce the part of Watt. As it was, troubles arose with the workmen and there was constant disputing. In an effort to effect improvement, Napier introduced a scheme under which his workmen were given a personal interest in the business. The scheme was not a success, and in due course Napier returned to the parental yard first as assistant and later to become a partner. Caring nothing for the rewards of business ability he gave his whole attention and thought to invention and improvement, which he pursued more for their own sake than for any pecuniary advantage which he was likely to derive from them. With Macquorn Rankine he collaborated in the production of many inventions in marine and general engineering and in the compilation of a voluminous treatise on *Theoretical and Practical Shipbuilding*. With Sir William Thompson he helped to form the Inventors' Institute with the object of securing a reform of the patent laws. On his own account he was one of the earliest to turn attention to steel as a shipbuilding material, and in 1867 designed and had built several steel vessels, shallow draught sternwheelers for the Indian rivers. His inventive genius, like Watt's and Parsons', roamed over a wide field extending from a liquid pressure log for measuring the speed of ships to means of heating and ventilating buildings on scientific principles. The Royal Society made him a Fellow, the British Association sought his services on many of its committees of investigation, he was made a Member of Council of the Institution of Naval Architects when that body was formed in 1860, and in 1865 when President of the Scottish Institution of Engineers took a principal part in the amalgamation of that body with the Scottish Shipbuilders' Association, a union which gave rise to the existing Institution of Engineers and Shipbuilders in Scotland. Yet for all his love of meeting with his fellows in learned debate, this man of plain and unpretending manners and kindly disposition generally preferred to give way to others who were more ready speakers. His papers and speeches were fragmentary. They contained much in the way of valuable hints and illuminating remarks, but so scattered were they and so deeply buried in the "transactions" that few benefited from them. All who came into immediate contact with him admired him. We to-day will probably be not far wrong if we describe him as a genius born too late to achieve lasting fame.

AMERICAN OIL PRODUCTION.—During 1938, over 1214 million barrels of crude petroleum were produced in the United States. The number of producing wells at the end of the year was 369,640, the average daily production of each well being 9·1 barrels.

Super High-Speed Pin-Hole Camera

By D. C. PRINCE and W. K. RANKIN*

FOR many years high-speed motion pictures have disclosed many details of the dynamic actions of athletes, &c., which are too fast for accurate observation by the unaided eye. These pictures made with professional 35-mm. cameras were first seen at theatres, but now, with the advent of 16-mm. film, cameras which will take pictures in the range from 4 to 8 times normal speed are available to the amateur. These speeds are possible with a camera in which the film is stationary when exposed and intermittently advanced when the light is cut off by the shutter. To avoid damage to the mechanism and film, it is necessary, when attaining much higher

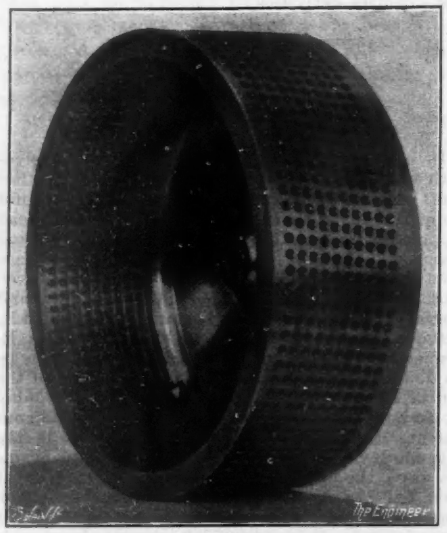


FIG. 1.—ROTATING PIN-HOLE DRUM

picture frequencies, to allow the film to run at a constant speed and to move the image optically with the film, and to make the exposure so short that there is no appreciable smearing of the image. A revolving prism or a system of mirrors may be employed as the optical system to move the image with the film. In general, when no optical system for shifting the image is employed, the objects to be photographed receive their illumination as pulses of stroboscopic light which are of sufficiently short duration that no motion of the image on the film can be detected. It is obvious that this method is

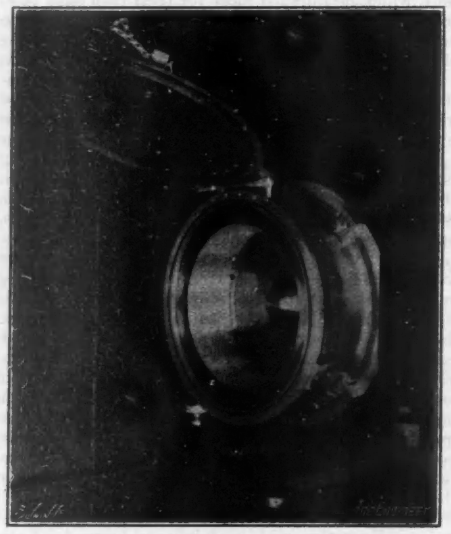


FIG. 2.—FILM AND CAMERA DRUMS

limited to photographing devices which do not continuously emit illumination on their own part.

In order to determine with great accuracy the timing and order of finishing of races, cameras operating at about 200 frames per second are used. Speeds up to 2000 frames per second have yielded a great deal of new information in the operation of mechanical motions, performance of electric arcs, &c. Since the normal speed of projection for silent film is 16 frames per second, the camera speed of 2000 frames per second allows about two minutes for the observation of the phenomenon taking place in one second.

It was determined that for photographing some circuit-breaker operations a camera which took pictures at the rate of about 100,000 frames per second would be necessary. A camera which is capable of taking pictures at the rate of 80,000 frames per second is being used for this purpose in Europe. This camera employs continuously moving film, a moving lens system, and a system of scanning discs. Some very fine work has been done with this camera, although the individual frames at maximum speed are only 1·8 mm. by 3 mm., so that the amount of possible enlargement is limited. Since in this camera the film is transferred from one spool to another during the taking period, a large amount of film must be used during acceleration, and also for synchronisation, even though the actual event observed may occupy only two or three inches of film. In observing an arc the total duration of which is less than $\frac{1}{60}$ of a second, with darkness before and after, it seemed as though there might be employed a continuous film mounted on a revolving cylinder, which could be exposed over and over again, more or less after the manner of the Boys camera for recording lightning strokes.

Recently in photographing arcs with one of the rotating prism cameras, it was observed that to prevent over-exposure in the brightest part of the arc it was necessary to cut down the illumination by using the smallest available stop in the lens diaphragm and, in addition, to employ dark filters. This suggested that, if a still smaller aperture were used, the lens system might be dispensed with altogether. In other words, the intensity of illumination in arcs is so great that it was thought a satisfactory exposure

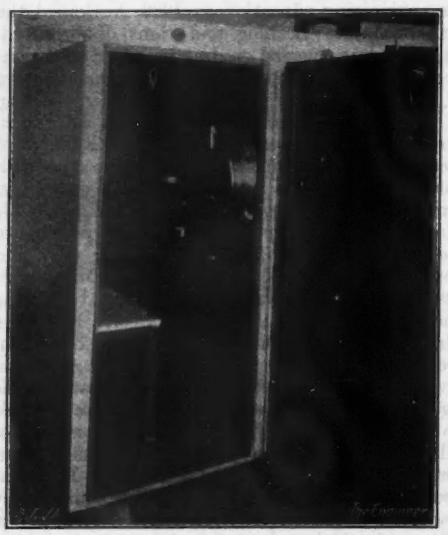


FIG. 3.—CAMERA CASING

might be obtained with a pinhole camera even at short exposure time.

DEVELOPMENT OF HIGH-SPEED PINHOLE CAMERA

A device was conceived which would consist of one thousand pinhole cameras arranged in ten rows of 100 holes each on a drum. By rotating this drum at 7200 r.p.m., a rate of exposure of 120,000 frames per second could be obtained. It was thought desirable to settle several questions of practicability before embarking on the actual design and manufacture of such a camera. Would the exposure be sufficient? Would definition be adequate? Would lateral translation of the pinhole cameras during exposure appreciably alter the shape of the image and spoil definition?

TESTS WITH THE PINHOLE CAMERA

To settle these points, a preliminary sample was made up in which two pinhole cameras were mounted on opposite ends of a revolving arm driven by a motor. The whole arrangement was mounted in a packing box so that the pinholes passed before a slit. With this crude apparatus exposures were made of a melting fuse wire. One of the two cameras caught the resulting flash. The other caught nothing. From this it was concluded that a sufficient exposure had occurred with one pass.

To determine definition, the elementary camera was run for eight minutes directed upon a calendar. In this way thousands of exposures were superimposed. The resulting photograph was practically perfect. Not only did this test settle the question of definition, but it also showed that rotational movement of the camera during exposure was harmless.

This test revealed an additional useful feature of the continuously rotating drum camera—namely, the ability of the camera to furnish a record of the background when photographing high-intensity arcs. When using a more or less conventional motion-picture camera, the proper exposure for the arc ordinarily leaves all other parts of the picture dark. With the rotating-drum camera, on the other hand, the background can be exposed (first or last) as long as necessary to bring out detail. The flash of the arc then photographs as it occurs amid its surrounds.

DESIGN FEATURES

Once the practicability of the principle had been demonstrated, it was possible to undertake the design with assurance of success. It was found feasible to design a metal drum capable of rotation at 7200 r.p.m. with a liberal factor of safety. This drum is shown in Fig. 1, and is the heart of the camera. Ten grooves are machined on the inside. Circular ribs between the grooves strengthen the drum and support the film at the proper distance from the apertures. At the root of each groove 100 holes are

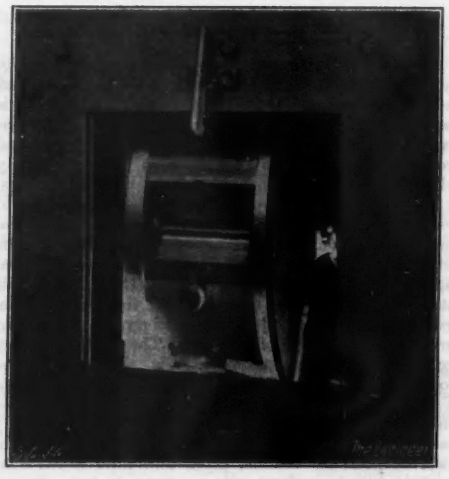


FIG. 4—COLLIMATING SLOT

drilled equally spaced around the circumference. The holes in adjacent grooves are displaced by one-tenth the pitch of the holes in one groove so that in effect the whole thousand holes are equally spaced around the drum.

The actual apertures are 0·010-in. holes punched in the centres of small black discs cemented into the drum. Each of the thousand pinhole cameras is used at a focal distance of less than one inch. This exposes a film area 9 mm. square, corresponding to a field 12in. by 12in. at 24in. from the aperture. In order that all ten rows of camera units may cover the same 12-in. by 12-in. area, the grooves vary in shape so that all are directed toward a common point 24in. away.

A single film 4½in. by 40in. covers the 1000 cameras.

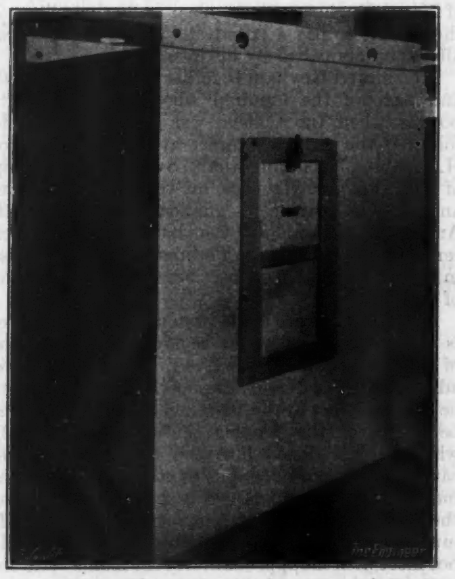


FIG. 5—PORTABLE DARK ROOM

Upon insertion this film is supported by a smooth drum as shown in Fig. 2. As the drum comes up to speed, the film is thrown into photographic position against the edges of the grooves by centrifugal force.

The film and camera drum are surrounded by a casing, Figs. 2 and 3, in which there is a collimating slot shown in Fig. 4, which acts as a shutter as the apertures pass across it. This slot is adjustable to vary the exposure time and may be 0·030in. wide before there is any overlap of the successive frames. The drum is driven by a ½-H.P. direct-current motor, which is run up to 7200 r.p.m., at which rate the entire 1000 frames are exposed in $\frac{1}{120}$ sec. or one half-cycle.

* *General Electric Review.*

This will give an exposure for every 10·8 min. of electrical arc, or every $8\frac{1}{3} \times 10^{-6}$ sec. Lower rates of exposure may also be obtained.

The stationary cylindrical casing which surrounds the rotating-film drum has a light-tight cover on which a finder is mounted, as will be seen in Figs. 3 and 4. Both horizontal and vertical adjustments for framing are provided. The whole camera is in turn mounted in a small portable darkroom, Fig. 5, to permit daylight loading. This darkroom, which is made of steel, also provides physical protection for the camera.

Application to Circuit-breaker Arc Studies

The camera has been designed and built primarily for the photographic study of arcs in circuit breakers; and one of a number of its successful applications in this service will now be described to show its capability.

The application concerned an air-blast circuit breaker, diagrammatically illustrated in Fig. 6. The air blast, which is transverse to the arc, carries

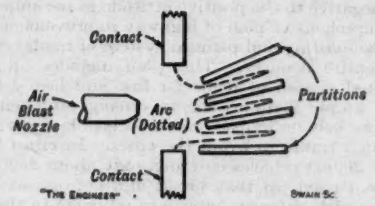


FIG. 6—AIR-BLAST CIRCUIT BREAKER

the arc against a series of cross partitions of insulating material. During the part of the cycle when the current is high, the arc is looped back in the space between the splitters, while the hot arc products are carried into a cooling structure which is not shown in Fig. 6. At current zero, the continuity of the hot arc path is broken at the splitters, and the hot gases are whirled away to the cooling structure. A series of frames leading up to a current zero, was obtained showing the extinction of the arc, which had, at its maximum, a current of nearly 6000 amp. Individual frames have been satisfactorily enlarged to 10in. by 12in.

Other Applications Possible

The camera is not limited to circuit-breaker research, however, and it may well be useful for the analysis of other brilliant high-speed phenomena of short duration. It is too early to predict just what discoveries will be made by the use of this new tool; but the camera seems certain to accomplish the specific purpose for which it was built. The possession of such a means of minute analysis should give access also to new and useful knowledge in other lines.

Aluminium Alloys and the Modern Steam Engine*

By E. D. ILIFF, B.Sc. (Eng.)

ALUMINIUM alloys have so far been but little used in steam engine design. The chief reason, of course, is that the reciprocating steam engine seldom attains the high speeds of the internal combustion engine; reduction of reciprocating and revolving weights has therefore been of relatively little importance, and steam engineers have felt in no way compelled to search for lighter materials. Their attitude to aluminium alloys has accordingly been conservative. To-day, however, there are signs that this attitude is changing, due largely to the experience of internal combustion engineers, and to the increasing speeds of steam engines, particularly of small auxiliary units.

The possible uses of aluminium alloys in steam engines can be most conveniently discussed under the following headings: (1) pistons; (2) crossheads; (3) connecting rods; (4) other moving parts; and (5) sundry stationary parts.

Pistons

By using an aluminium alloy instead of cast iron for pistons, a weight saving of as much as 50 per cent. may be effected—about the same as that normally obtained when aluminium alloy pistons are substituted for those of cast iron in an internal combustion engine. The chief considerations, however, in the design of steam and internal combustion engine pistons are somewhat different, and a comparison of the requirements of each may help to illustrate the particular properties of aluminium as a material for pistons.

An important feature in the internal combustion engine piston is good heat-flow, and this may be more important than simple mechanical strength. Hot-spots in the crown must be avoided and a smooth temperature gradient secured from the crown to the skirt. The gudgeon pin must not be allowed to get too hot, and thermal stresses in the bosses must be minimised. Designs are planned accordingly, and the provision of adequate strength at working temperatures in the crown and gudgeon pin bosses becomes a secondary requirement because it is more easily fulfilled.

The wide cyclic temperature changes in an internal combustion engine cylinder entail fluctuations of internal stress in the piston which will be aggravated if the temperature gradient is not smooth, and these thermal stresses may prove an important contributory cause limiting the life of the piston.

Since the coefficient of expansion of most aluminium alloys is somewhat higher than that of cast iron, the temperature changes tend to cause greater fluctuations of stress; but their higher thermal conductivity (about 4 times that of cast iron) makes it comparatively easy to secure a smooth temperature gradient. It is practicable, moreover, to thicken up an aluminium alloy piston where required for considerations of heat-flow without materially increasing the weight, whereas a cast-iron piston must be kept as thin as possible. It is true that the strength at high temperatures of aluminium alloys is appreciably lower than that of cast iron, but, owing to their high thermal conductivity and the greater freedom in design conferred by their low specific gravity, the working temperatures are very much lower than with cast iron pistons.

In the steam engine, by contrast, piston temperatures depend on the steam temperature, which is comparatively constant, and the problem of temperature gradient does not arise. The high thermal conductivity of aluminium, therefore, offers no advantage, but, equally, it can be no drawback, since the cylinder walls are lagged, and very little transference of heat takes place from the piston to the cylinder walls. Moreover, the high specific heat of aluminium (about 0·214 as against 0·125 for cast iron) tends to maintain the cylinder at constant temperature.

When the piston has been designed to give adequate strength at working temperature, it may be necessary to increase the scantlings to ensure that the piston is pressure tight. Choice of a suitable alloy, however, followed possibly by anodic oxidation and sealing, will effectually obviate leakage through the piston even if the scantlings are kept as thin as strength considerations will allow.

It can be seen that with steady temperatures and negligible heat-transference through the piston, the design of steam engine pistons is in many respects simpler than that of internal combustion engine pistons. The feasibility of substituting aluminium alloy for cast iron is necessarily dependent on the degree of superheat used owing to the sharply falling strength/temperature characteristic.

The accompanying figures show the properties that may be expected of the two principal alloys used for pistons:—

Alloy.	Density-lb. per cubic inch.	Thermal conductivity at 25 deg. Cent. C.G.S. Units.	Coefficient of thermal expansion per deg. Cent. 20–100	20–200	20–300
"Y" Alloy	0·100	0·35–0·41	0·0000225	0·0000234	0·0000245
"Lo-Ex" Alloy	0·097	0·29–0·34	0·000019	0·000020	0·000021

The tensile figures below are typical of those obtained with 1in. diameter test-bars cast in chill moulds, and the tests were made at a speed of approximately 0·1in. strain per minute after periods of 15 hours soaking at each of the temperatures indicated.

Ultimate Tensile Strength. Tons per square inch at Deg. Cent.							
Temperature:	20	100	150	200	250	300	350
"Y" Alloy	19½	19	18½	17	13	9	4½
"Lo-Ex" Alloy	21½	21	20	17½	10	6	3½

A question may here be raised regarding the comparative corrosion resistance of aluminium alloys and cast iron. The position is that dry steam will not attack most aluminium alloys, while wet steam does so only to a very limited extent, although steam, dry or wet, impinging at high velocity under pressure will tend to erode the material. While the engine is working, therefore, conditions do not usually tend to set up corrosion; but, as is generally assumed with internal combustion engines, it is while the engine is standing idle that corrosive conditions are most severe. Alloys are, however, available which are practically immune to the most severe conditions that are likely to occur. All corrosive action can effectively be inhibited by anodic oxidation of the piston, especially if this is followed by impregnation and sealing of the anodic film with oil or with a colloidal graphite preparation. This procedure will also reduce to a minimum wear of the piston in service.

Crossheads

Little use seems to have been made as yet of aluminium alloys for the crossheads of steam engines and pumps. The neglect of these alloys is probably largely due to failure to realise the suitability of materials which are now available. Since tensile and shear strengths are the chief considerations in crosshead design, a strong case can be put forward for the adoption of forged and cast aluminium alloys. The guaranteed minimum tensile properties of the strongest aluminium alloys, cast and forged, are shown in the accompanying table.

It will be seen from this table that the use of aluminium alloys, cast or forged, for crossheads will result in a very substantial saving in weight—again in the region of 50 per cent.—without diminution of strength. It should be noted that it may be advisable to provide thin steel shoes for the working surfaces of the crosshead.

Alloy Type.	Specification.	Form.	U.T.S. Tons per square inch.	Elongation per cent. on 2in.
Al/Cu/Mn/Mg/Si	DTD.364	Forged or Extruded	30	8
Al/Cu/Mg/Mn	B8S.5L1	,,	25	15
Al/Cu	DTD.361	Sand Cast	21	1
,,	,,	Chill Cast	26	4
,,	DTD.304	Sand Cast	18	4
,,	,,	Chill Cast	24	9
Al/Mg	DTD.300	Sand Cast	16	8

Connecting Rods

While aluminium alloy connecting rods have been adopted in many internal combustion engine designs, steam engineers do not seem to have used them to any great extent, although they have been employed with success for locomotives. Since working temperatures of steam engine connecting rods are in general lower than those of heavy-oil and petrol engine connecting rods, the full "cold" strengths of the material may be assumed to apply for design purposes in the former case, although in the latter the higher temperature may have to be taken into account.

Reduction of the weight of connecting-rods is, of course, more desirable than that of parts which have a simple reciprocating motion. Particularly is this the case in locomotives, where any diminution of unbalanced forces which produce rail hammer is extremely desirable. The lower modulus of elasticity of aluminium alloys must be taken into account when considering the column loads. With regard to the deflection of the rod resulting from the rotation of the big end with the crank pin, the lower specific gravity reduces the bending stresses and thus offsets the inferior modulus value.

Any reduction which can be achieved in the weight of the connecting rod is cumulative, since the crank pin bearing loads may be appreciably reduced thereby, and a lighter big end may consequently be permissible. It may be added that the bearing stresses at the crosshead pin and crank pin must be less than those allowable for steel rods, so that the bearing areas must be correspondingly increased. On the other hand, bushing of the little end is frequently unnecessary, and bearing metal may be poured directly into the big end as is the common practice with steel connecting rods. In this case the high thermal conductivity of aluminium will help to prevent overheating of the big and little ends.

Other Moving Parts

It is obvious that any reduction of inertia in the moving parts will have a direct effect on the efficiency of the engine. Moreover, the weight-saving is again cumulative in that the lower masses of these parts may reflect, for example, on the weight of the bed-plate, and on the size of the fly-wheel required to ensure smooth running.

The extent to which aluminium alloys could be used, and the advantages gained thereby, depend on individual design. No useful purpose would be served in further detailed discussion, although it may be mentioned in passing that another possible application of aluminium is in the construction of gear actuated by governors, where lightness would appreciably increase the sensitivity.

With regard to auxiliary gear, aluminium alloys may be used for pump pistons and bodies, or rotary pump impellers and other moving parts. The application of aluminium in the design of auxiliary gear might well extend to the construction of buckets for coal conveyors, etc., and would enable an appreciable reduction to be made in the horsepower taken by the conveyors. Particular conditions with regard to corrosion would, of course, have to be studied, in order to avoid both chemical and electrolytic action on the metal. The resistance of aluminium alloys to attack by most chemicals is satisfactory, and, in fact, is generally superior to that of ferrous and some non-ferrous metals. Electrolytic action may be obviated by ensuring that contact under damp conditions between dissimilar metals, such as copper and aluminium, does not exist.

Sundry Stationary Parts and Auxiliary Equipment

When reduction of dead weight is of importance, as for instance in the case of engines used for steam road vehicles or in ships, aluminium alloys may be used with confidence, since their strength/weight ratio compares favourably with that of other commonly used materials. Crankcases, sumps, brackets,

* Communicated by the Aluminium Information Bureau.

and other stressed parts may be cast in light alloys, which may also be adopted in certain cases for bedplates and frames.

Lightness is of particular importance for components which are frequently moved or handled, such as covers, doors, &c., and the saving in labour and maintenance costs during the life of the component may easily offset the higher first cost. Aluminium also offers advantages in the construction of engine-room platforms, ladders for boiler-houses, and so on, where weight-saving would enable a reduction to be made in the cost of scaffolding and supports. Here again, resistance to corrosive action —since aluminium alloys are, in general, highly resistant to attack by flue gases, coal gas, tar, &c.— represents another important factor in the employment of the metal.

Oil tanks, sumps, strainers, and pipes made in aluminium alloys are lighter and have the additional advantage of improved heat dissipation owing to their high thermal conductivity. Similarly, aluminium may be used in the construction of condensers and other auxiliary equipment in which heat dissipation is important.

In conclusion it must be emphasised that the full benefits which may accrue from the use of aluminium alloys are not realised until a comprehensive view is taken of aluminium in its many forms as an accepted structural material. Piecemeal substitution of light alloys for other metals is not likely to give the best results, and only when they are included initially in the design of complete units is the maximum advantage obtained from their use.

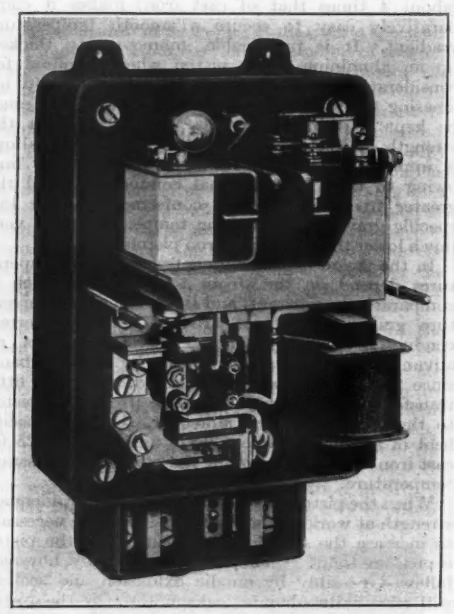
A Centralised Control System

A SYSTEM of centralised control of special signals for A.R.P. and other purposes has been developed by the Metropolitan-Vickers Electrical Company, of Trafford Park, Manchester, and an equipment has been put to work on the Blackpool corporation's system to meet the requirements of Mr. Harry F. Shanahan, the Borough electrical engineer. The system is known as the "Ripplay" system and when employed for load control, makes it possible to switch on or off from the power station any unit or group of lighting units or any other load on the network. For signal communication the system turns the whole of the electrical distribution system into a sort of broadcasting network on which simple receiving devices may be connected at various points to pick up and respond to appropriate signals.

As regards load control, every power distribution undertaking has difficult problems to meet in connection with loads requiring special control. In street lighting, for example, it may be necessary for the main lights to be switched on about sunset, the main lights to be switched off and low power lights on at about midnight, and the low power lights off at dawn.

While the extensive use of clock switches reduces the work involved, they demand the usual periodical winding and adjustment of settings to suit the changing length of day. Moreover time switches cannot take into account any time variations which may be desirable on account of light and dark days. For this reason they must be set for the worst probable conditions, with the result that on a bright evening the lights are automatically switched on before they are really necessary, thus involving a loss of energy. When alterations are made in "black out" arrangements "Ripplay" control is also advantageous. Other examples of load for which centralised control is desirable are shop windows, advertisements, decorative lighting and water heating at low tariffs at off-peak load. The switching off of such loads during the short peak load periods, may keep down the maximum demand and reduce the power costs to the undertaking.

With simple equipment, considering its capabilities, "Ripplay" control makes possible selected or group switching up to a very large number of independent operations. A simple and reliable method of transmitting warning or other signals to any point on the distribution network has obvious advantages. The method may be used for summoning the police and firemen. An air raid warning could be issued to all wardens in their own houses. The receiving device might even be made portable and used at various levels. A very large variety of switching on signal operations can be dealt with without confusion. The system superimposes on the normal 50-cycle supply, small ripples with frequencies ranging from 400 to 1000 oscillations per second without in any way affecting the normal power supply and without these ripples being detected except by the small devices used for the purpose. A large number of frequencies can be used for different switching or signal purposes, each frequency affecting only the particular device or devices set to respond to it.

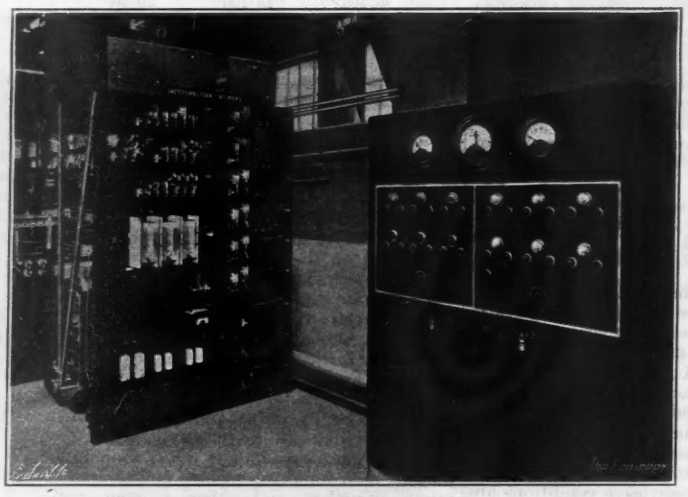


INTERIOR OF "RIPPLAY" DEVICE

By means of a dial on a control board, at the power station or other desirable point, the required ripple frequency may be selected, and by simply pressing a button the impulse is transmitted throughout the distribution system, thus giving rise to the operation of those particular receiving devices which are set to respond to it. The impulses are sent out on the existing high- or low-tension cables, available for the use of any consumer, and no change to the existing E.H.T. bus-bar equipment or to any of the main generation or distribution equipment is needed.

The system is applicable to any kind of network and is claimed to be the cheapest and most reliable equipment for the purpose. It is also economical in use, the power consumption for the signal impulses being negligible.

The illustrations show a control panel and contactor board for a Ripplay installation, a view of the equipment side showing the chokes and condensers and an internal view of the "Ripplay" device which receivers the signals and operates the switch.



CONTROL PANEL AND CONTACTOR BOARD

SIDE VIEW SHOWING CHOKES AND CONDENSERS

American Engineering News

A Co-ordinated Highway System

Periodically or perennially, the United States is subject to proposals for transcontinental high-speed motorways, without regard to the enormous and uneconomical cost or their relation to present and prospective roads. Such a project, providing for six "super-highways," three east and west and three north and south, was submitted by the Government to the Bureau of Public Roads for consideration, including the feasibility of the toll system for such super-highways. For an aggregate length of 14,360 miles the estimated cost is £580 million, or £40,450 per mile, while maintenance and operating costs would amount to £37 million annually. On a very liberal estimate, the toll collection could not exceed £14 million per year. From many points of view, such an undertaking is undesirable. But in reaching this unfavourable conclusion as to the proposed super-highway system, the Bureau's report changes from the negative to the positive attitude in recommending a comprehensive plan of highway improvement based on the existing and planned system of roads covering the entire country. This plan includes an inter-regional system of roads for fast and heavy traffic, with ample facilities for traversing large cities as well as belt or by-pass roads to enable a portion of through traffic to avoid the cities. In cities having some 20,000 vehicles entering, only about 2500 could be by-passed, so that broad and convenient routes across such cities are necessary adjuncts to the highway system. Improvements on main routes would be curve and gradient reduction, longer sight distances, straightening to reduce distances, separate lanes for fast and slow traffic, and removal of level crossings of roads and railways. In close relation must be the improvement and extension of secondary and feeder roads. Such a scheme of comprehensive and systematic improvement is far more useful and more generally beneficial than fantastic schemes for independent super-highways.

Tests of Steel at High Temperatures

High-temperature, sustained-load rupture tests on steel specimens, made at the laboratory of the General Electric Company, are recorded in a paper presented before the American Institute of Mining and Metallurgical Engineers. Ordinary tensile tests indicate the sustained load-carrying capacity under such temperatures and show that continuous plastic flow does not occur. At high temperatures, stresses below the short-time rupture value may produce continuous flow, with fracture occurring only after long periods. Service experience with stills, superheaters, and high-temperature boilers, shows that brittle fractures may occur without warning. Sustained load rupture tests are made to determine the expected life and corresponding ductility of various steels and alloy steels at various stresses and temperatures, as well as the effect of microstructure and metallurgical stability on the high-temperature properties. In these tests two cylindrical furnaces were used, each having twelve test bars at the same temperature and loaded by means of levers and weights. The investigation included accelerated tests in oxygen and rupture tests in hydrogen, the latter showing that intergranular fractures are not always caused by intergranular oxidation. The fragmented grains resulting from ductile transcrystalline fractures tend to support the theory that crystalline deformation must result from a shearing action. Higher temperatures and lower strains appear to favour intergranular cracking, and the temperature at which such cracking occurs seems to be related closely to the recrystallisation temperature of the steel. The effect of oxidation is to accelerate the time of fracture. Transcrystalline fractures are

accompanied by surface oxidation only. Intergranular fractures may or may not be accompanied by intergranular oxidation. Molybdenum and tungsten may increase creep and rupture strength, while chromium, silicon, and aluminium may increase the resistance to oxidation.

Cast Iron Fused to Steel

At the annual meeting of the American Foundrymen's Association there was an interesting description of the production of 25,000 brake drums for automobiles per eight-hour shift by an exceptional series of operations for melting, handling, and centrifugal casting. These drums, 10in. in diameter for cars and 16in. for motor trucks, consist of pressed steel shells with a lining of grey iron cast centrifugally and fused to the steel. The drums are of hot-rolled steel strip, rolled to circular shape and then electrically welded, trued and expanded, then washed by rolling through an inclined steam chamber. The foundry is peculiar in having no core room, moulding machines, or sand-handling equipment. Iron is melted in two 54in. hot-blast cupolas used alternately, the blast at 400 deg. Fah. being fed by stoker coal. The charge consists of coke, pig iron, and steel plate clippings, and borings made up in 4in. briquettes of 9 lb. weight, produced in an 1800-ton hydraulic press. The cupolas have water jackets around the melting zone. Iron is tapped at 2800 deg. Fah. to a 4-ton ladle, in which the sulphur is kept at a maximum of 0·10 per cent. It is taken by a 1-ton transfer ladle to a 4-ton electric furnace, and tapped on the opposite side at about 2900 deg. Adjacent to this furnace is a turntable carrying eighteen spinners for centrifugal casting, the table making a revolution in three minutes. Runner boxes attached to the spinners hold the exact amount within 0·1 lb. for each drum. Ladles from the electric furnace are poured at each box in turn, the spinner doors then closing automatically and the spinner revolving at 900 revolutions, or a peripheral speed of 3400ft. per minute. The door then opens automatically and the spinner drifts until braked to a stop. The drum is then attached to an overhead chain conveyor which passes through a cooling chamber and shot-blast cleaning room, a travel of 2000ft. To ensure complete fusion the drums are sprayed with flux and preheated to 1700 deg. Fah.

A New Vibrating Screen

In the accompanying engraving is shown a new development of the well-known "Rota-Vibra" vibrating screen, made by H. R. Marsden, Ltd., of Leeds. This new screen, known as the "Long Type Rota-Vibra," has been specially designed for the grading of coal and is arranged to deal rapidly and gently with even the softest coals. It requires but little headroom and is secured directly to the structure of the storage bin. It is practically noiseless in operation and is so balanced that no vibration is transmitted to the supporting structure, it being unnecessary to incorporate flexible or vibration damping connections.

Screening decks are arranged in sequence from the front end to the back of the machine and each screen panel can be tensioned independently. The machines can be arranged as a single unit with a number of decks, or in screens of two up to six, the power being applied to the first and thence from one to the other. In this manner a large number of gradings of material can be obtained, covering a considerable length of storage bin capacity. Our illustration shows two of the new screens arranged in tandem on a common underframe, and each has four or five screen panels, the machine being able to separate eight to ten different grades of material. One of its advantages is that the rejects are separated and discharged at the front end, thus giving higher screening efficiencies in the other grades by the elimination of mesh binding by the larger rejects.

The screens are made in unit sizes from 18in. wide by 20ft. long to 60in. wide by 20ft. long, with the desired number of panels. The proportionate tonnages are from 10 to 60 per hour and the power consumption from 5 to 15 B.H.P. dependent upon the specific gravity of the material being graded.

VIBRATING SCREEN FOR GRADING COAL

A Fast Fireboat

The hard chine fast boat which has now risen to such an important position in the marine world, has been applied to a variety of uses, and a recent interesting development is its employment for fire fighting purposes. It is an axiom of fire fighting that seconds saved in reaching the scene of the fire with the necessary appliances may make all the difference between a small blaze and a conflagration. This principle has led the London County Council Fire Brigade to explore the possibilities of building a hard chine boat which would have a higher speed than the large firefloats and auxiliary fire boats, but yet be able to carry pumps of adequate capacity.

In conjunction with the Chief Officer of the Brigade, Commander A. Firebrace, R.N. Retired (now the Regional Fire Officer), J. Samuel White and Co., Ltd., produced a design satisfying the requirements which resulted in the order for the "James Braidwood" being placed with the firm.

The design requirements were met in a ship of the following dimensions :—

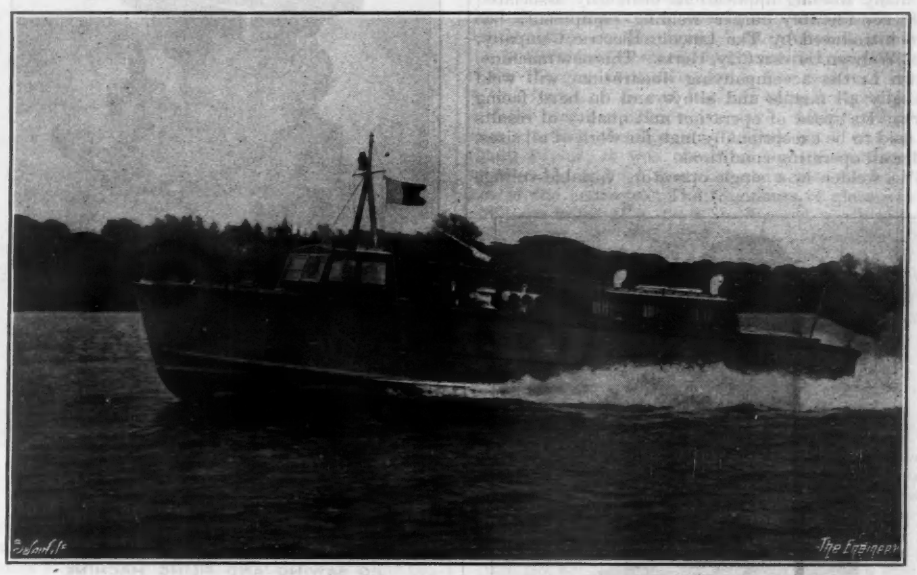
Overall length	45ft.
Beam over planking...	10ft.
Depth moulded	5ft. 3¼in.
Maximum draught	3ft. 6in.
Designed speed	20 knots.

As the hull was built to the firm's "Whitecraft" hard chine design, which in the past has been well proved to give efficient service, the novelty of the "James Braidwood" lies in its equipment rather than in the hull itself.

In considering the layout of the available space in the boat, it was necessary to provide, in addition to the machinery and navigation compartments, a suitable platform from which to conduct fire fighting operations.

As will be seen from the accompanying engraving the wheelhouse is placed well forward, aft of which is an open cockpit fitted with fore and aft seats, and from which a door gives access to a storage compartment for the necessary gear and equipment. Aft of this store is the engine room, which contains both the pumping and propelling machinery, access being obtained through a hatch. Aft of the engine room is a large cockpit. The fuel tank is fitted in the stern, an electric petrol gauge being provided in the wheelhouse for indicating its contents. Ample headroom is provided in the machinery space, the deck over the storage compartment and the forward end of the engine room providing the necessary platform for firefighting operations.

Three six-cylinder Meadows petrol engines, each designed to develop 110 H.P. at 2700 r.p.m., are installed for propulsion purposes and are directly coupled to three propeller shafts. The wing engines are utilized for driving the fire pumps, each driving a Dennis turbine pump through a Croft patented friction clutch and a Layrub flexible coupling. The Dennis pumps are of exactly the same design as those used in the land fire appliances and each has a capacity of 750 gallons per minute at a pressure of 100 lb. per square inch, making a total output of 1500 g.p.m.



THE L.C.C. FIREBOAT "JAMES BRAIDWOOD"

The two pumps discharge into a common pipe system which conveys the water to both a Dixon 5in. bore monitor and to swivelling deck boxes to which hoses can be connected as required. The major part of the discharge pipe system is made of silicon aluminium alloy castings in order to save weight and reduce the number of joints. A great deal of thought has been given to the arrangement of the pump suctions so as to minimise the possibility of river debris impeding the flow of water to the pumps. Should complete or partial choking of a suction, however, take place, this can be cleared by the application of water under pressure from the discharge from the opposite pump. It is also possible to remove the internal strainers for cleaning whilst under way, and if necessary to clean the suction grid from the inside of the boat.

Ample deck space has been provided for operating the monitor and handling the hoses, the deck being covered with non-slip rubber to assist in obtaining a good foothold.

All controls for navigation purposes are situated in the wheelhouse, where a complete set of instruments for the three engines is mounted on a neat dashboard.

Throttle controls for the engines, interconnected with those in the wheelhouse, are also provided in the engine room, together with the pump vacuum and pressure gauges, so that complete local control of the pumping plant is available.

The height of the superstructure has had to be limited, so that no fixed objects are more than 7ft. 6in. above the waterline, thus enabling the boat to be used in the canals if necessary; and these conditions entailed the hinging of the bipod mast, so that it can be quickly lowered when necessary.

The electrical equipment provided is designed on generous lines, current being generated by three 12-volt dynamos arranged to charge two 120 amp.-hour D.P. Kathanode batteries.

In addition to a number of lighting points an 11in. searchlight is fitted, and a Kent clear-view screen, all power and lighting being fed from a distribution board which carries fuses for all circuits.

The Essex "Featherspray" system of fire extinguisher is provided and is controlled from the wheelhouse, sprayers being arranged at all hazardous

points. An Amal flame trap to the fuel tank filler furnishes an additional precaution. A No. 10 "Pyrene" foam making branch pipe and tank also forms part of the fire fighting equipment.

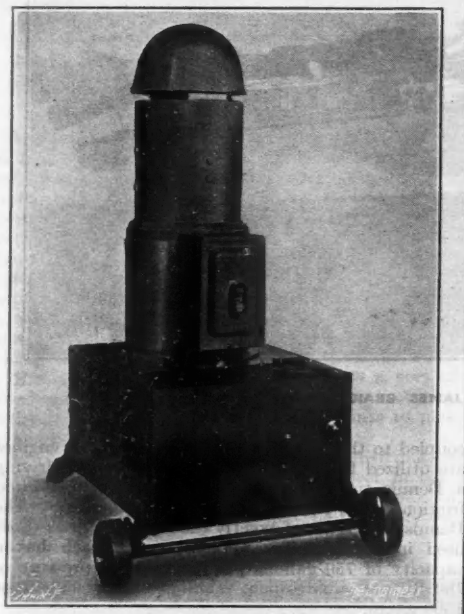
During the recent official trials the boat reached a mean of means speed of 20·197 knots, and proved fully capable of fulfilling the requirements of the Fire Brigade in the comprehensive series of trials that were specified.

The construction of the "James Braidwood" has been carried out under the supervision of Mr. F. Dewhurst, A.M.I.Mech.E., A.M.I.A.E., the Mechanical Engineer of the London Fire Brigade, and to the survey of Lloyds Register of Shipping.

A 200-Ampere Arc Welder

A NEW 200-ampere motor generator arc welder known as the "Lincoln Junior type," with a range for many welding applications ordinarily associated with considerably larger welding equipment, has been introduced by The Lincoln Electric Company, Ltd., Welwyn Garden City, Herts. This new machine, shown in the accompanying illustration, will weld virtually all metals and alloys and do hard facing work. Its speed of operation and quality of results are said to be exceptionally high for work of all sizes, under all operating conditions.

The welder is a single-operator, variable-voltage



MOTOR GENERATOR ARC WELDER

machine and can be used with either bare or shielded arc-type electrodes. It has a current range of 25 to 250 amperes. A special feature, now available for the first time on small arc welding machines, is the Lincoln patented dual continuous control, which permits independent adjustment of voltage and current, giving complete and separate control of arc heat and arc penetration, essential for best and most economical production of sound welds in the varied present-day arc welding applications. The advantages of this feature will be readily apparent in shops, garages, plants, &c., using small portable welding equipment. Setting the welder is simplified by the fact that both voltage control and current control are self-indicating.

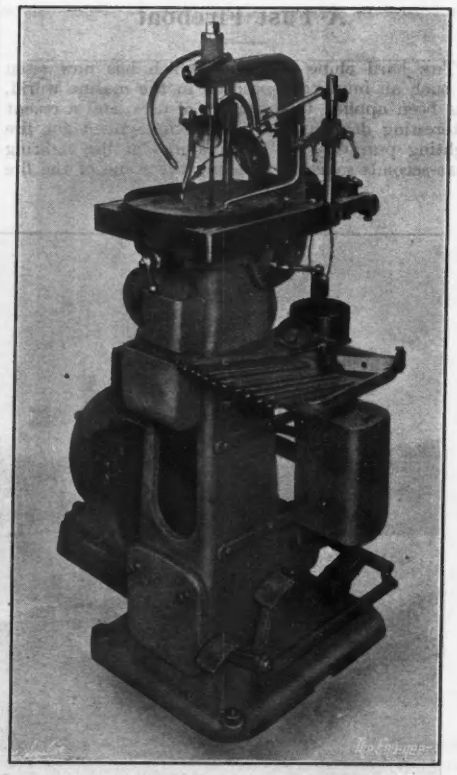
Another feature of the machine is its insulation. The use of Class B insulation at certain points enables the unit to withstand sustained overloads, for the insulation contains no inflammable material. The coils, wound with glass-covered wire, are held in mica-lined slots separated by mica dividers, and the leads are connected into the commutator by special high-melting-point solder. End turns are insulated with mica tape.

The motor is a squirrel-cage machine designed for across-the-line starting. Connections are readily available for either 220 or 440 volts. The machine is also made for 550 or other voltages and for 3 or 2 phase. Constructed of welded steel the motor has four steel feet welded to the base and drilled for bolting in permanent position or for attaching of three-wheeled running gear. The welder occupies less than 4 square feet of floor space. A lifting lug facilitates crane handling.

A Jig Sawing and Filing Machine

A NEW jig sawing and filing machine has recently been added to the "Rapidor" range of machines, by Edward G. Herbert, Ltd., of Levenshulme, Manchester. As may be seen from the accompanying engraving it has a heavy one-piece box-section stand, on to which is bolted the driving motor and gear-box. Its 15-in. square work table is mounted on a cradle so that it can be tilted up to 15 degrees in four directions. This tilting arrangement enables rapid and easy adjustment to permit the cutting of clearances when working on dies and the like.

The T-section saw frame is guided by a 1¼-in. square 45-ton carbon steel slide bar, working in long bearings, and it is fitted with attachments for easy



JIG SAWING AND FILING MACHINE

change-over from sawing to filing. There is a clearance of 9in. between the cutting tool and the frame, and workpieces up to 3in. thick can be accomodated for either sawing or filing. The stroke of the machine is adjustable from 0 to 4in. Two rigid pillars are set in the back of the work table and attached to these by hand clamps are the brackets of two adjustable work stays. An adjustable mirror reflector and an electric lamp are also mounted on these pillars. Work is held against the tool, and fed in by means of a gravity feeding attachment operated by weights suspended from the rear of the machine. Chips are removed from the work by an air blower, and a dust chute removes cuttings and filings. The equipment also includes a magazine for coil saw blades and holders for straight hacksaw blades and standard files 10in. long.

Standard machines are driven by a four speed A.C. motor through a worm gear box in which the gears run in oil. Speeds of 222, 145, 111, and 72·5 strokes per minute are obtained and this range coupled with the variable stroke gives a wide choice of cutting speeds. Control is by means of a clutch operated by a foot pedal.

Grease gun lubrication is provided, and long life with the minimum of wear is ensured by the fitting of phosphor bronze bearings with hardened and ground shafts and crank pins throughout the machine. Although the motor driven machine is regarded as a standard, a belt driven model is being made.

An Electric Furnace for Bright Hardening Dies

RESEARCH metallurgists of the Westinghouse Electric and Manufacturing Coompany, East Pittsburg, Pa., have introduced a new steel hardening furnace that uses a "blanket" of gas to prevent "singeing" the metal while it is toughened at temperatures as high as 2000 deg. Fah. By means of a delicately balanced atmosphere of pure hydrogen and nitrogen, this automatic electric furnace is able to harden many steels gently without quenching them in oil or water, thus eliminating distortion and formation of scale. Development of the new furnace and air-hardening technique is attributable to Dr. A. A. Bates, manager of the chemical and metallurgical division of the Westinghouse Research Laboratories, and Mr. Howard C. Scott, research metallurgist.

The furnace, shown in the accompanying illustration, is approximately 7ft. long and is designed so that a piece of steel passes through it at varying stages of heat, ranging from approximately 1300 deg. to 1750 deg. Fah., before it cools in an air-cooled tunnel. Maintenance of an atmosphere of oxygen-free gases inside the furnace prevents any reaction in the steel which would distort or mar the metal. The steel shows no outward evidence of having passed through the furnace.

Pieces of ordinary steel, polished to a mirror finish, are said to retain their finish after a four-hour hardening treatment in the new apparatus.

The combination of controlled atmosphere and temperature enables the metallurgist to harden steel pieces in their finished form with a resultant bright finish and without the expense and delay of additional machining.

Ordinarily steel is hardened by heating it in air, and cooling it quickly in oil or water. The heat and the quenching combine to form the crystalline structure of the metal in the shape of millions of microscopic "icicles." These are not apparent to the unaided eye, but from observations through powerful microscopes, metallurgists know that a piece of highly hardened steel no larger than the head of a pin consists of millions of these "icicle" formations. In striking contrast to this crystalline structure, metal in the annealed or softened state has a structure resembling a mass of finger-prints.

Coincidentally with the development of the automatic furnace, the investigators have produced a new steel designed for the manufacture of dies which are hard enough to scratch glass. These dies are said to retain their bright surface, and are hardened uniformly throughout their mass, because their internal crystalline structure has been so completely re-arranged by the graduated heat treatment and gentle cooling.

The principal ingredients of the new hard steel are iron, carbon, vanadium, molybdenum, and chromium. The distortion characteristics of the resultant metal after tempering are said to be as good as or better than

BRIGHT HARDENING ELECTRIC FURNACE

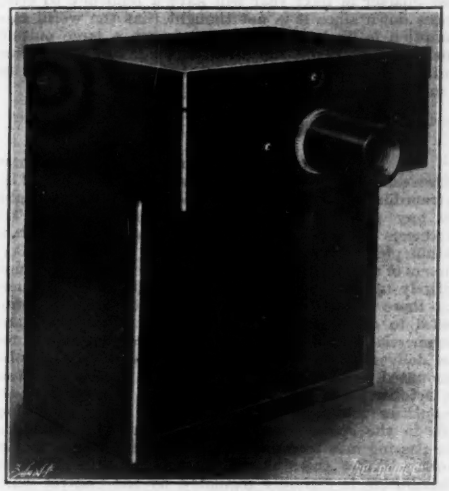
in high carbon high chrome steel, and are considerably better than the best to be found in the commonly used manganese oil-hardened steels. General results show a change of dimensions under one one-thousandth of an inch per one inch of metal.

The new metal is claimed to offer potential economies of from 40 to 60 per cent. in the manufacture of dies. In the electrical industries such dies form the transformer iron, conductors, and many other parts used in the precise construction of modern electrical apparatus. In the motor car industry, dies of hardened steel are used to shape such deeply-formed parts as fenders, bodies, and head lamps. Unless they were made of the most expensive high speed steels, such dies and tools previously had to be cut from a block of steel, shaped and hardened by cooling quickly in a liquid, and then corrected for the distortion.

The furnace tilted to a 20 degree angle prevents contamination of the lighter-than-air gas atmosphere in which tool steels are bright hardened. With the furnace not one steel die or tool was spoiled out of 350 hardened.

An A.R.P. Lighting Fitting

THE accompanying illustration shows an Ediswan lighting fitting for A.R.P. or road direction sign illumination. Although this fitting is designed to comply with the Light (Restrictions) Order, 1939, permission for its use must first be obtained from the competent local authority. Known as the Ediswan "Controlume" fitting, it has been developed



"CONTROLUME" LIGHTING FITTING

on scientific principles to meet the exacting requirements of the Lighting Restrictions Act, which demands a definite illumination for authorised signs which have to remain legible during the hours of "black-out" and even during an air raid.

The fitting must be used only with a 15-watt, 28-mm. pygmy sign lamp, access to which is readily obtained by removing the detachable cover at the top of the unit. Accurate control of the light output and distribution is obtained from an optical system comprising a specially calibrated reducing screen in conjunction with adjustable shutters. These confine the light to the face of the sign panel, thus precluding a direct view of the light source and avoiding illumination of the ground. At the back of the fitting a ¾-in. conduit socket is provided for direct attachment to a conduit arm, but an alternative mounting can be effected by means of a mild steel strap suitable to the particular situation.

The fitting is designed for illuminating sign panels up to a maximum size of 48in. wide by 36in. deep, but when ordering it is desirable to state the size for which the fittings are required when, if necessary, further technical information will be given.

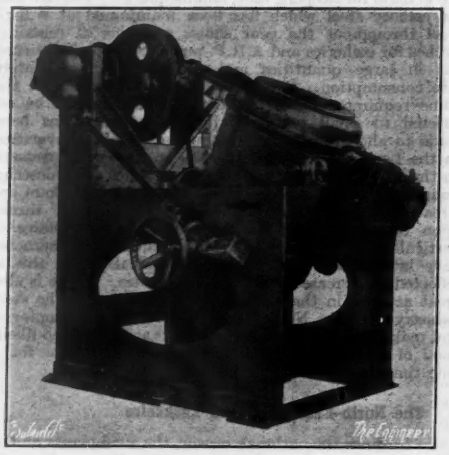
A Metal-Melting Furnace

A RECENT addition to the range of tilting furnaces made by the Monometer Manufacturing Company, Ltd., is shown in the accompanying engraving. This furnace is made in three sizes having capacities of 600, 1000, and 1500 lb. for brass and 200, 300, and 500 lb. for light alloys. It is also designed to take standard sizes of crucibles.

The furnace is set in a substantial fabricated steel frame and the axis about which it tilts is in line with the spout. By this arrangement the spout always remains in the same position for pouring directly into moulds.

Tilting is effected by turning the handwheel on the side of the frame. This handwheel is connected through worm gears and two universal joints on an intermediate shaft to a main shaft across the top of an extension at the rear of the frame. On the main shaft are mounted three pulleys which actuate the counterbalancing means for tilting the furnace. The large central pulley is connected by a chain to a quadrant on the bottom of the furnace, and fixed to a point on the circumference of each of the smaller pulleys are attached chains, on the other ends of which are suspended counterbalance weights. When the handwheel is turned the main shaft is rotated to wind up the chain of the main pulley and tilt the furnace. The weights on the smaller pulleys at the same time give an assisting torque to the shaft and a retarding force is exerted when the furnace is being restored to the melting position.

Combustion air is preheated in the dome of the furnace, it being forced by a fan at the bottom up a pipe at the rear of the furnace, round the dome, and down a second adjoining pipe leading to the burner. These pipes are fixed but have spherical ends on which the branches from the rear of the dome, seen clearly in the engraving, automatically seat themselves in the melting position. The dome is heated



OIL FIRED TILTING FURNACE

by the heat contained in the refractory lining of the furnace, and the resulting pre-heated air not only ensures a dry atmosphere inside the furnace but produces greater pressure at the nozzle. This pre-heating of the air also permits the use of a heavier oil than would be otherwise possible. A sealed chamber at the top of the furnace prevents the products of combustion reaching and contaminating the molten charge.

When firing by heavy oil, the furnace melts light metals in between 1½ and 2 hours for a charge of 500 lb. of aluminium, the oil consumption being about one gallon per 100 lb. of metal. We are informed that for melting 1500 lb. of high temperature bronze the time ranges between 2 to 2½ hours, with an oil consumption of approximately one gallon per 100 lb. of metal.

A low-pressure burner is used working at a pressure of 26 to 30in. water gauge with a volume of 16,000 to 20,000 cubic feet of free air per hour. A micrometer gauge permits the burner to be set in such a way that the proportion of oil used per metal charge may be kept at the correct figure. The furnace may also be arranged for gas firing.

Glass for A.R.P.

AN exhibition was recently held at the London offices of Pilkington Brothers, Ltd., St. Helens, Lancs., in which were shown some applications of the firm's glass products in A.R.P. work. The exhibits of particular interest to engineers, builders, and architects were those in which the company's "Armourplate" type glass were shown. As is already known, this glass will bend, twist, and resist heavy blows and high temperatures. Bricks made of it, set in concrete frames, have been found to offer considerable resistance to blast. They have the particular advantage that whilst affording excellent protection they do not shut out all of the day-light as in the case of windows protected by sandbags.

There were also shown toughened glass lenses for use in concrete roofs and similar work, and the exhibits included examples of such lenses which had been subjected to tests with incendiary bombs. Early tests showed that "Armourlight" lenses, as they are called, set in concrete, provide full protection against elektron bombs burning on the surface. In the event of a lens being shattered by a direct hit from a falling incendiary bomb, however, this protection would probably be ineffective, and a double glazed system of construction has been devised to give a large measure of additional protection against this eventuality. A series of tests has been carried out on double glazed units, consisting of pairs of lenses held together round their edges by a bituminous material and set into 5in. of reinforced concrete.

It was not possible to devise any experimental method of reproducing precisely the effect which would be produced on a lens by the direct impact of a 2lb. bomb falling with a terminal velocity of 400–500ft./sec. In carrying out the tests it was assumed that the bomb would shatter the first lens, but that, in consequence of the great strength of toughened glass, the bomb would be finally arrested in its fall when it struck the second lens. For one of the tests, a double glazed unit, consisting of two 7in. diameter circular lenses set in concrete, had its top lens broken, and an elektron bomb was placed in the hole, resting on the bottom lens, and ignited. The bomb burned 1 minute fiercely and 15 minutes slowly, and most of the elektron metal melted down on to the lens. The lower lens cracked on cooling, after 25 minutes, giving an annealed fracture in the centre, and a toughened fracture round the edge. The lens, however, remained in position and did not allow any burning material to pass. In another test with a thermite bomb, a double glazed unit of 7in. diameter lenses cast in 5in. thick concrete had its upper lens broken and knocked in. The bomb was placed in the hole, resting on the bottom lens, and ignited. In 1 minute 10 seconds, the bomb sank right into the hole and a pool of molten iron formed on the glass debris, lying on the lower lens. After 4 minutes the bottom lens cracked, but remained in position. When the glass was examined a few moments later, it was found to be red hot. It sagged about ¼ in. with the heat, but did not give way. After 6½ minutes from starting, the iron was "black-hot," and after about ½-hour, it was observed that a wide crack between ¼in. and ½in. had occurred across the bottom face of the concrete. The fragments of glass which had been knocked in from the broken top lens had melted together. The lower lens had broken with an annealed type of fracture in the centre, but with a toughened (diced) fracture near the edges. The lens was still firmly in position when the slab had cooled down and it prevented passage of any incendiary material.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

SIZES OF ROAD STONE AND CHIPPINGS

(B.S. No. 63).—In this revision one of the major modifications has been the adoption of square mesh sieves (B.S. 410) for testing the size of the chippings in place of the round hole sieves and the hand gauges that were previously specified. In view of the fact that this change will necessitate appreciable alterations to the existing equipment in quarries, it was considered desirable that due notice of the change-over should be given both to users and producers. The requirements of the revised standard will not, therefore, come into effect until January 1st, 1940. In preparing the revised issue account has been taken of two major criticisms of the previous issue. These were as follows:—(*a*) No tolerances were laid down for the amount of oversize material to be allowed in material of a given size; (*b*) Thirty per cent. of undersize was allowed in each standard size but no limits of size were associated with this amount—it might all be dust. The grading tolerances have, therefore, been amplified to cover these points and the tolerances now specified have been drawn up after a careful study of present-day quarry practice. A revised list of the trade names of road stone is included for general information.

LUBRICATING OILS

(B.S. No. 210).—The classification of pure mineral lubricating oils, which was issued as B.S. 210 in 1924 by the British Standards Institution, has now been revised, and an attempt has been made in the revision to make clearer the fact that it is a classification intended to be a broad guide to users of lubricating oils, but it is not a specification and does not provide detailed specifications for individual oils. The introduction of new processes of manufacture has made necessary a revision of the classification and a reconsideration of the significance of the tests employed. The classification consists of definitions of five main groups, each sub-divided—as commercially practised—into viscosity grades under the names, light, medium, and heavy, and for convenience the corresponding units of kinematic viscosity in centi-stokes are given.

FOAMED BLAST FURNACE SLAG FOR CONCRETE REINFORCEMENT

(B.S. No. 877).—This specification is the first of a series which is in preparation for concrete aggregates generally. The standard for foamed blast furnace slag has been based on research carried out by the Building Research Station in collaboration with the Blast Furnace Committee of the Iron and Steel Industrial Research Council. The standard is restricted to material having a lime content within 50 per cent and the requirements included cover weight per unit volume, impurities (electrical test), combustible matter (ignition test), stability, and presence of sulphate. Details of the methods by which the various tests have to be carried out are given in the appendices. It is recommended that concrete made with this aggregate should not be used for outside work without the protection of a rendering.

PROPOSED LARGE AMERICAN POWER STATION.—A new power station which will have an ultimate capacity of 500,000 kW has been planned by the Philadelphia Electric Company. It is to be built in South Philadelphia by the Delaware River, at a cost of about 45 million dollars.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.

The American Steel Market

The American iron and steel market is enjoying a boom which is reminiscent of conditions during the last war. At the beginning of December production was at the rate of 94·40 per cent. of capacity. The change in the export trade brought about in that country is particularly noticeable as the American steel trade has benefited from the limited attention which the European steel industries have been able to give to overseas trade. An interesting transaction was the placing of an order for steel sheets by Japan, valued at $500,000. This order had been placed with German works, but as delivery was unobtainable it was transferred to an American company. Great Britain is also reported to have placed orders for 25,000 tons of semi-finished steel. The Argentine State Railways have placed a contract for 200 tank cars, and the Brazilian Government for 500 freight cars. To complete the latter order the Pullman Company has reopened its freight car shops at Baltimore. The United States at the present moment appears to be the principal market for scrap and the Italian steel industry has recently purchased 150,000 tons. For some months past Japan has taken 50,000 tons per month and this average seems likely to be maintained. Reports are also current that the sale of 500,000 tons has been made to the British steelmakers for delivery next year, whilst the balance of 250,000 tons of the purchases made earlier in the year which has not been delivered is to be shipped. It is understood that the arrangement as regards price includes an adjustment on the unshipped balance and the provision for a sliding scale based on fluctuations in the American market on forward shipments. The American tinplate mills are experiencing boom conditions and are working at 96 per cent. of capacity, whilst the hot rolled sheet and strip works are producing at 80 per cent. to 82 per cent. and the galvanised sheet departments at 75 per cent. Buying by the American railway companies has been active lately and recent orders for rails have totalled 40,000 tons. A contract for 1000 ore cars of 90-tons capacity and 1000 steel gondola and box cars of 50-tons capacity will require the use of 20,000 tons to 25,000 tons of rust-resisting steel. No decision has yet been made with regard to steel prices in 1940, but it is expected that adjustments on extras and allowances will be made in order to remove inequalities and provide higher average returns.

The Pig Iron Market

Whilst there is a certain amount of stringency in the pig iron market the position does not give rise to any apprehension and although some brands are difficult to obtain, consumers are receiving regular supplies. The stringency seems most acute in the basic pig iron department owing to the huge quantities required by the steelmakers to maintain their outputs. The use of scrap has increased and although there is no super abundance of this material the position in some districts has been eased by imports. The concentration of effort upon the production of basic pig iron has affected the output of other descriptions and there is little expectation that the production of Cleveland foundry iron will be restarted on the North-East Coast. The manufacture of this brand was suspended before the war and with the gradual absorption of the stocks in the makers' hands, it was thought not long ago that it would be resumed. Consumers of foundry iron in that district, therefore, are obtaining their supplies largely from Midland sources and the Control seems to be encouraging this movement. This gives the pig iron makers a freer hand to increase the output of basic iron. The foundries are well employed and few complaints are heard regarding the distribution of supplies. In the Midlands it is generally recognised that the system of distribution is working equitably and satisfactorily, although some firms with stocks are inclined to resent the policy of the Control in restricting new purchases. In the majority of cases, however, it is recognised that stock replacements in the present circumstances are neither to the advantage of the industry nor the country. The gradual improvement in the light castings industry has created a better demand for high phosphoric pig iron. Not only are the light castings makers getting a larger proportion of war contracts, but they are also in the position of being able to take a certain amount of commercial work. The Scottish pig iron industry is working at considerable pressure. Foundry iron is in good demand and in some cases the makers are getting behind with deliveries. There is a certain amount of irregularity in the position of the light castings foundries, but there appears to be a gradual increase in the numbers which are being turned over to Government work. Continental foundry iron has recently been offered to the Scottish market, but the price has been too high to enable business to be transacted. The position in the hematite market is almost unchanged. Consumption is sufficient to take up the full production, but there is no shortage and most of the makers have some stocks in hand. Some attempt has been made by consumers to place orders for 1940 delivery, but the producers are disinclined to accept far forward business.

Scotland and the North

Every department of the Scottish iron and steel trade is busy and although the demand is more pressing in some sections than in others practically the whole industry is operating at capacity. In some branches production has reached record levels. The output of semi-finished steel is maintained at a high rate, but is insufficient to meet the full needs of the re-rollers. Recently there has been a distribution of imported semi-finished steel but most of the consuming works would have been glad to receive larger quantities than were available. It is understood, however, that arrangements have been made which will have the effect of materially increasing the imports and some relief may therefore be afforded. Large tonnages of shipbuilding steel are passing to the Clyde yards and it is expected that the requirements of the shipbuilding industry will expand as time goes on. Delivery dates appear to be lengthening particularly in the case of plates and sections used in shipbuilding. Large quantities of structural steel of all descriptions are passing to the constructional engineers. This material is needed in large quantities for the execution of Government contracts and it is not likely that there will be any dimunition in the demand from this quarter. The locomotive engineers and tank and boiler makers are insistent in their demands for plates and the works have enough orders for this class of material on their books to keep them busily engaged for several months without depending upon fresh business. The demand for railway material has also increased lately, and considerable orders are in hand for sleepers, rails, and fishplates. The demand for colliery steel which has been maintained at a high level throughout the year shows no signs of relaxing. Arches for collieries and A.R.P. purposes are being turned out in large quantities and are passing immediately into consumption. Owing to the heavy pressure of the home requirements, export business has had to be restricted to small tonnages, but an attempt has been made to allocate a certain amount of steel for overseas. In the Lancashire market there is an unceasing pressure on the part of consumers to obtain supplies of all descriptions of steel. The order books of the plate-makers are already congested but business continues to be thrust upon the works and the demand for boiler plates is particularly vigorous. Contracts of a substantial character have lately been received by this industry and this is reflected in increased pressure for supplies. There is also great activity in the bright steel bar section. The steel industry on the North-West Coast is fully employed and makers' order books are so full that there is no likelihood of any slackening in the rate of operations for a long time.

The North-East Coast and Yorkshire

Since the outbreak of war, the steel plants on the North-East Coast have been operating at capacity, and it has been assumed that outputs could not be further increased. Lately, however, it is understood that there is a tendency for production figures to rise. The demand shows no signs of subsiding, and in fact with every increase in production there appears to have been a corresponding or even greater expansion in the requirements of the consuming trades. Some makers are almost entirely engaged upon work required for national purposes, but others have a certain amount of capacity available for work of a commercial character, although the delivery dates are extended. There is a tendency also for works to fall into arrears with their deliveries, although the Control has successfully kept those consumers engaged upon Government work supplied with steel. There is no relaxation in the pressure to secure structural steel of all descriptions and most of this material is taken up by constructional engineers who are engaged upon important contracts for the Government. These requirements are likely to be maintained for a long time, and according to some reports may increase rather than decline. The re-rollers, also, are being pressed for deliveries of small bars and sections. To a certain extent their outputs are affected by the stringency in the supply of billets. Lately foreign billets have been distributed, but the supply has not been sufficient to bridge the gap between the home production and the re-rollers' demands. It is understood, however, that arrangements have been practically completed which will ensure further supplies of steel for this branch of the industry. All the shipbuilding yards have full order books, and large tonnages of plates and sections are finding an outlet in this direction. Here again no relaxation in the pressure for supplies can be expected for many months as may be gathered from statements by the Government on the shipbuilding programme. The output of sheets is well maintained, but the makers are now rapidly completing their A.R.P. contracts for sheets and are accepting export business and home business of a commercial description. As yet, however, there is not a great deal of plant available for the latter. In the Yorkshire steel industry conditions have not changed much for the last week or two. The works are inundated with orders and few of them are able to keep pace with the demand. In the Sheffield district the plants purchasing basic steel have order books sufficient to keep them busy well into 1940. The production of acid carbon steel also is on a heavy scale, and deliveries of both qualities are becoming greatly extended.

Copper and Tin

The consumption of copper remains at a high rate, but, so far as can be ascertained, supplies are freely available for all firms engaged upon Government contracts. The Control, however, carefully scrutinises applications for licences, and apparently it is not considered advisable to encourage those for metal to be used for commercial purposes. The discussions between the Ministry of Supply and the Metal Exchange regarding the re-opening of the latter are continuing, and it is understood that proposals have been placed before the Ministry which in the opinion of members of the Exchange should meet the requirements of the authorities. Whilst the Metal Exchange is out of commission, so far as copper is concerned, the New York market is becoming increasingly important. Although a certain number of neutral consumers continue to buy through London merchants who cover their orders in America, a larger number are going direct to the United States, and during the last week, considerable orders have been placed by Japan and Italy. The neutral buyers, however, experience difficulty in obtaining the necessary shipping to carry the metal. The American market has become rather easier, largely because consumers since the war began have bought as much copper as they will need for some time. In fact the impression is that some of the big users have overbought. The falling off in the demand, however, has not affected prices which remain at about £20 over the British official maximum of £51 for electrolytic. There is a section of the metal trade, however, which feels that the British price was pegged at too low a level, and will eventually have to be raised. The non-ferrous metals Control provided a surprise at the beginning of this week by removing the restrictions on the tin market in Great Britain, whilst simultaneously the Colonial Office withdrew price restrictions in the East. As might have been expected the price in London advanced to £271 10s., and in unofficial dealings later on, on December 11th, rose to £282 from the previously fixed maximum of £230. This raises the price to about the same level as has ruled in the United States for some time. For several weeks the market has been restricted to dealing in 25 tons per day; but upon the removal of the restriction the turnover increased to around 400 tons. This turnover did not represent physical metal as it was due to hedging, a certain amount of jobbing, as well as the buying of actual metal. The removal of the restriction has in fact brought the price to the world level, but it is expected that after a time values will recede. It is understood that the restrictive price level of £230 was imposed at the request of the United States where prices in the early days of the war rushed upwards. American consumers have bought recklessly and probably have considerably more tin on their hands than they actually need. At the same time the recent decision of the International Tin Committee to increase the quota to 120 per cent. for the first quarter of next year will have a tendency to bring prices down since it is not thought that the world consumption is likely to take care of such a large output. For a time no doubt the Americans will continue to buy and this will keep the price up, but later there may be a substantial decline.

Lead and Spelter

The position in the lead market appears to have grown easier in some respects of late although, in view of the extraordinary heavy demand, little metal seems available for any purpose other than Government work. The producers of lead products also state that it is difficult to obtain pig lead for materials required for export. Consumers of all descriptions appear to be now engaged almost entirely upon Government work of national importance; but there are still some firms who would like to obtain metal to complete home trade contracts of an ordinary commercial character. According to American figures, the deliveries of lead in the United States in November amounted to 60,000 short tons, against 66,060 short tons in October. For the ten months ended October 31st, the quantities totalled 445,838 tons. . . . Active conditions rule in the spelter market, and considerable quantities are passing into consumption by firms engaged upon war work. Whilst there is no shortage of this metal, its distribution is carefully regulated by the Control which seems unwilling to provide metal for anything but purposes of national importance. It would appear that the production of spelter in this country is not at its maximum, and this is probably due to the slower arrival of concentrates as a result of the convoy system. Although it is probable that there is no surplus metal, there is certainly enough to meet the war-time needs of consumers, and later on it is probable that supplies will increase. It is generally thought that there will be little opportunity for importing metal from foreign countries, since any transactions which would necessitate the use of foreign exchange would be frowned upon by the authorities in the national interests. It is stated that the Consolidated Smelting and Refining Company of Canada will supply the British Government with its surplus production of spelter, after Canadian requirements have been met. It is estimated that this will amount to about 100,000 tons. In the United States, the spelter market has become less active, and one of the big companies has lowered its price to 6c. per lb., East St. Louis. Other producers, however, are endeavouring to maintain the price at 6·50c.

Non-Ferrous Metal Average Prices

The London Metal Exchange official average prices for copper, tin, lead, and spelter for November are chiefly a reflection of the official quotations fixed by the Controller of Non-Ferrous Metals. The only variation occurs in the price of tin which is less controlled than the other metals. The average quotation for standard cash tin advanced to £230—the official maximum figure—from £229 19s. $5\frac{11}{21}$d. in October, whilst for three months the price also rose to £230, compared with the October average of £229 15s. $8\frac{3}{11}$d., the settlement price being £230. The following are the official average quotations for November :—

STANDARD COPPER ...	Cash (mean)	£46	0	0
	3 Months (mean) ...	£46	0	0
	Settlement		—	
ELECTROLYTIC COPPER (MEAN)...		£51	0	0
DITTO DITTO WIRE BARS		£51	0	0
B.S. COPPER (mean) c.i.f.		£49	10	0
STANDARD TIN	Cash (mean)	£230	0	0
	3 Months (mean) ...	£230	0	0
	Settlement	£230	0	0
LEAD	For shipment the current month (mean)	£16	12	6
	For shipment the third following month (mean)	£16	12	6
	Mean	£16	12	6
	Settlement		—	
SPELTER	For shipment the current month (mean)	£15	0	0
	For shipment the third following month (mean)	£15	0	0
	Mean	£15	0	0
	Settlement		—	

Current Prices for Metals and Fuels

Official maximum home trade prices, per ton, delivered buyers' stations. *Joists, Sections, Bars and Plates are subject to a rebate of 15s. to home users purchasing only from Associated British Steelmakers. †Export prices are for approved specifications and destinations.

PIG IRON.

Foundry home prices, except for Scotland, less rebate of 5/–. (*D/d Teeside Area.*)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Hematite Mixed Nos.	6 4 6	—
„ No. 1	6 4 6	—
Cleveland—		
No. 1	5 10 6	—
No. 3 G.M.B.	5 8 0	—
No. 4 Foundry	5 7 0	—
Basic	5 1 6	—
MIDLANDS—		
Staffs— (*Delivered to Black Country Station.*)		
North Staffs Foundry	5 10 0	—
„ „ Forge	5 7 0 to £5 9 0	—
Basic	5 1 6	—
Northampton—		
Foundry No. 3	5 7 6	—
Forge	5 4 6 to £5 6 6	—
Derbyshire—		
No. 3 Foundry	5 10 0	—
Forge	5 7 0 to £5 9 0	—
SCOTLAND—		
Hematite, f.o.t. furnaces	6 4 6	—
No. 1 Foundry, ditto	5 12 0	—
No. 3 Foundry, ditto	5 9 6	—
Basic, d/d	5 1 6	—
N.W. COAST—		
Hematite Mixed Nos.	6 4 6 d/d Glasgow 6 10 0 „ Sheffield 6 16 0 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export, nominal. £ s. d.
LANCS. AND YORKS—		
Crown Bars	12 15 0	12 5 0
Best Bars	13 0 0	12 15 0
MIDLANDS—		
Crown Bars	12 15 0	12 5 0
Marked Bars (Staffs)	15 15 0	—
No. 3 Quality	11 5 0	—
No. 4 Quality	11 15 0	—
SCOTLAND—		
Crown Bars	12 15 0	12 5 0
Best	13 0 0	12 15 0
N.E. COAST—		
Crown Bars	12 15 0	12 5 0
Best Bars	13 0 0	12 15 0
Double Best Bars	13 15 0	13 5 0
NORTHERN IRELAND AND FREE STATE—		
Crown Bars, f.o.q.	13 7 6	—

STEEL.

	*Home. £ s. d.	†Export. £ s. d.
LONDON AND THE SOUTH—		
Angles	11 10 6	11 2 6
Tees	12 10 6	12 2 6
Joists	11 10 6	11 2 6
Channels	11 15 6	11 7 6
Rounds, 3in. and up	12 10 6	12 2 6
„ under 3in.	13 1 6‡	12 5 0
Flats, under 5in.	13 1 6‡	12 5 0
Plates, ¾in. (basis)	11 15 6	11 2 6
„ 7/16in.	12 0 6	11 7 6
„ ½in.	12 5 6	11 12 6
„ 7/16in.	12 10 6	11 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	nom. 11 12 6
Boiler Plates, ¾in.	12 13 0	nom. 11 12 6
NORTH-EAST COAST—	£ s. d.	£ s. d.
Angles	11 8 0	11 2 6
Tees	12 8 0	12 2 6
Joists	11 8 0	11 2 6
Channels	11 13 0	11 7 6
Rounds, 3in. and up	12 8 0	12 2 6
„ under 3in.	12 19 0‡	12 5 0
Plates, ¾in. (basis)	11 10 6	11 2 6
„ 7/16in.	11 15 6	11 7 6
„ ½in.	12 0 6	11 12 6
„ 7/16in.	12 5 6	11 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6
Boiler Plates, ¾in.	12 8 0	11 12 6
MIDLANDS, AND LEEDS AND DISTRICT—	£ s. d.	£ s. d.
Angles	11 8 0	11 2 6
Tees	12 8 0	12 2 6
Joists	11 8 0	11 2 6
Channels	12 13 0	11 7 6
Rounds, 3in. and up	12 8 0	12 2 6
„ under 3in.	12 19 0‡	12 5 0
Flats, 5in. and under	12 19 0‡	12 5 0
Plates, ¾in. (basis)	11 13 0	11 2 6
„ 7/16in.	11 18 0	11 7 6
„ ½in.	12 3 0	11 12 6
„ 7/16in.	12 8 0	11 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6
Boiler Plates, ¾in.	12 8 0	11 12 6
GLASGOW AND DISTRICT—	£ s. d.	£ s. d.
Angles	11 8 0	11 2 6
Tees	12 8 0	12 2 6
Joists	11 8 0	11 2 6
Channels	11 13 0	11 7 6
Rounds, 3in. and up	12 8 0	12 2 6
„ under 3in.	12 19 0‡	12 5 0
Flats, 5in. and under	12 19 0‡	12 5 0
Plates, ¾in. (basis)	11 10 6	11 2 6
„ 7/16in.	11 15 6	11 7 6
„ ½in.	12 0 6	11 12 6
„ 7/16in.	12 5 6	11 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6
Boiler Plates, ¾in.	12 8 0	11 12 6
SOUTH WALES AREA—	£ s. d.	£ s. d.
Angles	11 8 0	11 2 6
Tees	12 8 0	12 2 6
Joists	11 8 0	11 2 6
Channels	11 13 0	11 7 6
Rounds, 3in. and up	12 8 0	11 2 6
„ under 3in.	12 19 0‡	12 5 0
Flats, 5in. and under	12 19 0‡	12 5 0
Plates, ¾in. (basis)	11 13 0	11 2 6
„ 7/16in.	11 18 0	11 7 6
„ ½in.	12 3 0	11 12 6
„ 7/16in.	12 8 0	11 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	12 12 6	11 12 6
IRELAND—F.O.Q.—	BELFAST. £ s. d.	REST OF IRELAND. £ s. d.
Angles	11 8 0	11 10 6
Tees	12 8 0	12 10 6
Joists	11 8 0	11 10 6
Channels	11 13 0	11 15 6
Rounds, 3in. and up	12 8 0	12 10 6
„ under 3in.	12 19 0‡	13 1 6
Plates, ¾in. (basis)	11 10 6	11 13 0
„ 7/16in.	11 15 6	11 18 0
„ ½in.	12 0 6	12 3 0
„ 7/16in.	12 5 6	12 8 0
Un. 7/16in. to ¼in. incl.	12 12 6	12 15 0

‡ *Rounds and Flats tested quality; untested, 3s. less.*

OTHER STEEL MATERIALS

Sheets.	Home. £ s. d.	Export, f.o.b. £ s. d.
11-G. and 12-G., d/d	15 2 6	11-G. to 14-G. 14 0 0
13-G., d/d	15 10 6	15-G. to 16-G. 14 10 0
14-G. to 20-G., d/d	15 17 6	17-G. to 18-G. 14 15 0
21-G. to 24-G., d/d	16 2 6	19-G. to 20-G. 15 0 0
25-G. and 26-G., d/d	16 17 6	21-G. to 24-G. 15 12 6

Irish Free State, minimum £16 2s. 6d., f.o.q., 24-G. basis.

The home trade sheet prices are for 4-ton lots and over; 2-ton to 4-ton lots, 7s. 6d. per ton extra; and under 2-ton lots to 10-cwt., £2 2s. 6d. per ton extra.

Galvanised Corrugated sheets, basis 24-G.—

Home.	£ s. d.
4-ton lots and up	18 12 6
2-ton to 4-ton lots	19 6 0
Under 2 tons to 10 cwt.	20 12

Export: General, £18 2s. 6d., f.o.b., 24-G. basis.
Irish Free State, minimum £18 12s. 6d., f.o.q.

TIN-PLATES—
20 by 14 basis, f.o.t., Bristol Channel Ports, 21s. 6d.
Tin-plate Bars, d/d Welsh Works, £8 5s.

BILLETS—100-ton lots and over, 35 to 100 tons, 5s. extra; less than 35 tons, 10s. extra.

	£ s. d.
Soft, untested	8 7 6
„ (up to 0·25% C.), tested	8 12 6
Basic (0·33% to 0·41% C.)	8 17 6
„ Medium (0·42% to 0·60% C.)	9 10 0
„ Hard (0·61% to 0·85% C.)	10 0 0
„ „ (0·88% to 0·99% C.)	10 10 0
„ „ (over 0·99% C.)	11 0 0
Rails, Heavy, 500-ton lots, f.o.t.	10 3 0
„ Light, f.o.t., up to and including 25 lb. per yard	12 2 6

FERRO ALLOYS.

	Per Ton.
Tungsten Metal Powder	4/5½ per lb.
Ferro-Tungsten	4/4 per lb.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£38 10 0 (nominal)
„ „ 6 p.c. to 8 p.c.	£37 0 0 (nominal)
„ „ 8 p.c. to 10 p.c.	£37 0 0 (nominal)
„ „ Max. 2 p.c. carbon	£58 0 0 (nominal)
„ „ „ 1 p.c. carbon	£60 0 0 (nominal)
„ „ „ 0·5 p.c. carbon	no quotation
„ „ „ carbon-free	1/2d. per lb.
Metallic Chromium	3/6 per lb. (nominal)
Ferro Manganese (loose), 76 p.c.	£18 to £19 home
„ Silicon, 45 p.c. to 50 p.c.	£19 10 0
„ „ 75 p.c.	£28 10 0
„ Vanadium	14/– per lb.
„ Molybdenum	5/6 to 5/7½ per lb.
„ Titanium (carbon-free) 20/25 p.c.	11d. per lb.
Nickel (per ton)	£190 to £195 per ton
Cobalt	8/– to 10/– per lb.

NON-FERROUS METALS.

(*Official Prices, December 12th.*)

COPPER—	
Electrolytic	£51 c.i.f. U.K. ports
Billets	£55 „
Cakes	£51 12 6 „
Cathodes	£50 10 „
Wire rods	£55 d/d buyers' premises
Sheets, Hot rolled	£85 0 0
	Home.
Tubes, Solid Drawn (basis)	13½d.
„ Brazed (basis)	13½d.
BRASS—	
Ingots, 70/30, d/d Birmingham	£43 to £44
	Home.
Tubes, Solid Drawn 2/1 Alloy	12½d.
„ Brazed	14½d.
TIN—	
Cash	£272 0 0 to £272 10 0
Three Months	£268 0 0 to £268 10 0
SPELTER—	
G.O.B. Foreign	£15 ex ship, (duty for buyers' account).
Empire zinc	£17 5 ex ship, London.
LEAD—	
Pig lead, foreign	£16 12 6 ex ship (duty for buyers' account).
Empire lead	£17 ex ship.
Aluminium Ingots (British)	£110 (net)

FUELS.

SCOTLAND

	Export.
LANARKSHIRE—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	22/6 to 23/–
Hamilton Ell	23/–
Splints	24/–
AYRSHIRE—	
(f.o.b. Ports)—	
Steam	21/–
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	22/–
Unscreened Navigation	22/6 to 23/–
LOTHIANS—	
(f.o.b. Leith)—	
Hartley Prime	22/–
Secondary Steam	21/3

ENGLAND

SOUTH, YORKSHIRE, DONCASTER—	
Hards	20/– to 24/–
Washed Smalls	21/7
NORTHUMBERLAND, NEWCASTLE—	
Blyth Best	22/–
„ Second	21/–
„ Best Small	18/6
Unscreened	20/– to 21/–
DURHAM—	
Best Gas	22/6
Foundry Coke	29/3 to 30/–

SOUTH WALES

CARDIFF—	
Steam Coals:	
Best Admiralty Large	26/4 to 27/10
Best Seconds	25/10 to 27/4
Best Dry Large	25/4 to 27/4
Ordinaries	24/– to 26/–
Bunker Smalls	19/10 to 22/4
Cargo Smalls	18/4 to 19/4
Dry Nuts	31/4 to 32/10
Foundry Coke	50/– to 60/–
Furnace Coke	39/– to 40/–
Patent Fuel	27/6
SWANSEA—	
Anthracite Coals:	
Best Large	34/– to 36/6
Machine-made Cobbles	36/– to 43/–
Nuts	36/6 to 45/6
Beans	37/6 to 42/–
Peas	30/– to 31/–
Rubbly Culm	16/– to 17/–
Steam Coals:	
Large Ordinary	23/– to 26/–

FUEL OIL.

Inland consumption: supplies in bulk: exclusive of Government tax of 1d. per gallon (other than for use in Diesel-engined road vehicles).

D/d prices in London of Oil for supplies in bulk—	Per Gallon
Pool Fuel Oil	5½d.
Pool Diesel Oil	6d.

All supplies are now controlled by the Petroleum Board and all prices are on a day to day basis and subject to alteration without notice.

French Engineering Notes

(From our own Correspondent in Paris)

Foreign Machinery Trade

THE pooling of Anglo-French economic resources to carry on the war is regarded in this country not merely as a temporary expedient of the greatest importance, but also as offering a possible basis for international trade if all countries should be disposed eventually to settle down to a confident desire for co-operation. For the present, it is an idea that must remain vague until it is seen whether the mechanism of the pool created for special conditions can have anything in it which can be adapted to normal international trade. So far, the collaboration between the two countries with regard to purchases of what is necessary for the conduct of the war is accompanied by further facilities for trade exchanges. These facilities apply to certain goods and produce which each country is better able to supply the other without prejudicing the national production of either. The principle of reciprocal trading therefore remains. Opportunities for widening this reciprocity were lessened after the last war partly by an increased engineering production which was expanded to cover all branches of the industry. There was a surplus production capacity that could only be utilised by introducing new manufactures. In like manner, the tremendous effort now being made to increase production for national defence will, when hostilities cease, leave many works and factories with little or nothing to do. The transition from war to peace work will be made easier if manufacturers are provided with means of carrying on an export trade. Those makers who are not engaged on armaments have at present little choice in obtaining raw materials and have a difficulty in securing suitable workers, but with a long war in prospect these obstacles to trade expansion are to be removed as far as possible. Branches of the engineering trades that are particularly affected by foreign competition are strongly organised, particularly machine tools and agricultural machinery. The machine tool industry has developed rapidly in accordance with a definite plan that aims at production for export, and large quantities of machines were supplied to Great Britain in the early period of preparations for armament work. The pressure on the industry has now still further expanded production among makers who are perfectly organised and will no doubt find it necessary to keep the home market as far as possible to themselves after the war. In agriculture the shortage of labour at a time when everything must be done to increase production has aroused exceptional interest in the mechanisation of farms. Here again, the agricultural engineering industry has enjoyed a large measure of protection, and still has in view a virtual monopoly of the home market. If the interests of particular industries are alone to be considered there is a limit to foreign exchanges. This state of things is opposed to the policy of foreign trade exchanges which is regarded as a national necessity. The real tendency is observable in the constitution by the State of an advisory committee to deal with the whole question of farm mechanisation. In addition to half a dozen representatives of agricultural engineering associations and three representatives of agricultural federations, there are State departments including the Minister of Commerce and the Minister of Foreign Affairs. Consequently, the advisory committee covers all interests, and whatever is done must fall in with the general interest, which is that encouragement shall be given to an industry up to the point where it does not conflict with the interests of consumers or prove an obstacle to the carrying out of commercial arrangements abroad that are necessary to the national economy. Reciprocity in foreign exchanges will continue on as large a scale as possible so long as there is no risk of endangering vital national interests.

The Bordeaux-Merignac Air Port

When the Bordeaux Chamber of Commerce created the aerodrome at Mérignac, a few miles outside the former town, one of its objects was to provide a terminus for a Transatlantic line of land aircraft. The seaplane terminus is the Etang de Biscarosse, a land-locked sheet of water on the coast to the south-west of Bordeaux. There was then some discussion regarding the relative economic advantages of flying boats and land aircraft, an argument in favour of the land machine being that its lighter weight would allow of more petrol being carried and of flying at higher altitudes at greater speeds, thereby enabling the machine possibly to make direct non-stop journeys between France and New York. Many of the flights across the South Atlantic have been accomplished by Farman and other land aircraft. The recent flight of the Farman type of "stratosphere" machine from Paris to Rio-de-Janeiro, shows that the idea of a North Atlantic direct service has not been abandoned, and, following upon this performance, official sanction has been given to the execution of plans for completing the Bordeaux-Mérignac air port. The work comprises the construction of a third hangar, 150 m. by 40 m., the same dimensions as the other two, and the completion of one of the two taking-off and landing tracks that cross each other at an angle of 45 deg. The existing track has a length of 1400 m. The tracks were designed specially for big Farman machines.

Trade Fairs

It will take some time for commercial production to recover from the effects of the general mobilisation and requisitions of machinery and material, but the situation is already improving, and there is good reason to hope for an early recovery when the Minister of Armaments has completed his plans for giving all the help he can to manufacturers compatible with national defence requirements. Commercial production must be increased as a factor in national economy, which is also allied to national defence. The holding of the usual trade fairs is under consideration. The date of the Lyons Fair has already been fixed for April 13th to 21st, but no decision has been announced with regard to the Paris Fair, where large crowds of visitors would presumably offer too much risk in the present situation. Nevertheless, the fairs would have a useful effect on trade in centres where they can be held with safety, and it remains to be seen how far the example of Lyons will be followed.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patents Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR

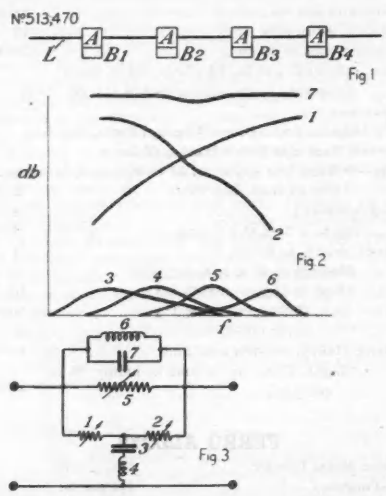
513,492. April 7th, 1938.—ELECTRIC SWITCHES WITH PRODUCED EXTINGUISHING GAS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

This invention relates to self-generating gas blast electric switches, that is to say, switches in which gas for arc extinction is evolved from a near-by member by the action of the switching arc thereon. In such switches the member is usually arranged to surround the path of separation of the contacts or as a rod within the tubular switch contacts, and is customarily constituted of a material such as fibre, which readily evolves gas under the influence of the arc. According to the invention a material, capable of evolving gas under the influence of an electric arc when used in self-generating gas blast electric switches, comprises an explosive material and a combustion retarder capable of restricting the evolution of gas by the decompoaition of the explosive material to the parts directly exposed to the arc. By this means, the explosive decomposition of the explosive materials contained in the switch chamber walls is restricted, through the addition of the combustion retarder, to those points that are directly exposed to the influence of the arc. Therefore the desired explosive decomposition of the layers of the chamber walls exposed to the arc influence does not immediately extend to other layers underneath. A mixture is produced from polymerised vinyl carbazole, ground while retaining the fibrous structure, with an addition of barium peroxide and 10 per cent. to 30 per cent. nitro-cellulose with a nitrogen content corresponding to that of collodion. This mixture is given an addition of urea-formaldehyde resin, and is extruded to form quenching tubes and quenching tube pins respectively. The fibrous vinyl carbazole here serves as a rigid carrier, the urea resin as a binding substance, while the addition of barium peroxide, *i.e.* of a substance emitting oxygen at high temperatures, has the purpose of oxidising into carbon dioxide the carbon that is formed during the gasifying process. On the other hand, where quenching tubes or filling pins produced by winding are concerned, then the procedure may be as follows: Lengths of paper or fabric are produced, are impregnated with urea-formaldehyde resin and then wound. If lengths of paper are used, then these may consist, for example, of fibres of a nitro-cellulose composition with a nitrogen content of approximately 8 per cent. In order to increase the mechanical strength, cellulose fibres, especially sulphite cellulose, asbestos fibres, and other suitable fibre, may be added.—*October 13th*, 1939.

TELEGRAPHS AND TELEPHONES

513,470. March 8th, 1938.—ELECTRIC TRANSMISSION LINES, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Douglas Aubrey Ley, of The General Electric Company, Ltd., Telephone Works, Stoke, Coventry, Warwickshire.

This invention has reference to electric communication transmission lines and relates in particular to electric transmission lines having associated therewith means for equalising the frequency attenuation of the line. In Fig. 1 the line L is shown divided into five sections, the length of each of which is equal to one of a series of predetermined lengths. In the present example these predetermined lengths are 5, 10, 15, and 20 miles. Between each section a simple main equalising network A of bridged-T type is provided, each of which is adapted to equalise approximately the attenuation of one of these predetermined lengths of line and is associated with a section of that length. The attenuation characteristic of the first section of line is shown in curve 1, and that of the associated main equaliser in curve 2 of Fig. 2. It will be seen that although the former is



substantially straight the latter has a dip. These dips are an inescapable feature of networks of such simple design and they occur at different portions of the frequency spectrum for networks designed to equalise the attenuation of sections of different lengths. Curve 7 of Fig. 2 shows the combined characteristics of the first section and its associated main equaliser. The transmission line shown in Fig. 1 has several such sections connected in series and as, in this embodiment, the sections are all of different lengths, the overall attenuation characteristic has a series of dips. These are eliminated by connecting an auxiliary equaliser in series with each main equaliser. The circuit diagram of the preferred form of auxiliary equaliser is shown in Fig. 3. This equaliser is a bridged-T network also and comprises a T network having resistances 1 and 2 as its series arms and a series resonant circuit, made up of a condenser 3 and an inductance 4, as its shunt arm, a resistance 5 and a parallel resonant circuit made up of an inductance 6 and a condenser 7 bridging the series arms of this T network. The resistances 1, 2, and 5 are each provided with four tappings so that the height of the peak of the attenuation characteristic may be adjusted to any one of four predetermined values, the tapping points being selected in a manner well known in the art. These auxiliary equalisers are made to a number of designs each adapted to produce an attenuation of a few decibels over a narrow band of frequencies and each having the peak of its attenuation characteristic in a different portion of the frequency band which the line is adapted to transmit. In the present arrangement four different designs are used, their attenuation characteristics being shown in curves 3, 4, 5, and 6 of Fig. 2, and by suitably choosing and adjusting these equalisers compensation is applied to make the overall attenuation curve of the line over its whole length substantially flat.—*October 13th*, 1939.

MISCELLANEOUS

512,622. March 7th, 1938. VITREOUS SILICA AND OTHER REFRACTORY VITREOUS SILICEOUS MATERIALS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and John Henry Partridge, of Research Laboratories of The General Electric Company, Ltd., Wembley, Middlesex.

This invention applies to the manufacture of highly refractory vitreous siliceous material (and in particular of vitreous silica) of the type wherein the material is brought into the vitreous state by melting it in a carbon crucible. If the melted material is allowed to cool in the crucible, it adheres so firmly to the crucible that, when the ingot is separated from the crucible, fragments of the surface of the ingot are broken from it, leaving the surface rough and irregular. The object of the invention is to prevent such surface fractures and to produce a smooth and regular ingot. It has been found that this object can be obtained by burning away the carbon while the ingot is solid but above its annealing temperature, so that it yields under stress. If the ingot is of silica an appropriate temperature for this part of the process is 1300° C. With other siliceous materials so refractory that it is convenient to melt them in a carbon crucible, most (if not all) of which also adhere to carbon, the appropriate temperature may be somewhat different. According to the invention the manufacture, of the type specified, of highly vitreous refractory siliceous material comprises the step, subsequent to the melting, of maintaining the carbon crucible containing the material in an oxidising atmosphere at a temperature at which the material is solid but can yield under stress until the carbon crucible is burnt away. It is to be understood that, after the melting and before the step, the material must not be allowed to cool so far below the annealing temperature that it cracks. Manufacture according to the invention is particularly convenient when the material is melted in an induction furnace; for then the carbon crucible can be supported, during the melting, by being packed in refractory material such as zirconia. Consequently the crucible can be very thin. After melting, the material is allowed to cool till it is just solid; the crucible is then transferred to a furnace containing air maintained at 1300°–1400° C. till the carbon is burnt away. If the interior of the crucible is smooth, the resulting ingot will be equally smooth.—*September 29th*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

North-East Coast Institution of Engineers and Shipbuilders

To-day, Dec. 15th.—Mining Institute, Newcastle-upon-Tyne. "Open-Water Test Series with Modern Propeller Forms," Part II, "Three-Bladed Propellers," L. Troost, and "Some Notes on High-Temperature Marine Superheaters," H. Hunter. 6 p.m.

Institute of Fuel

To-day, Dec. 15th.—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "Improvement in Calorific Value of Town's Gas or Coke Oven Gas with special reference to Utilisation as a Fuel for Motor Vehicles," J. I. Graham and D. G. Skinner. 2.15 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tuesday, Dec. 19th.—39, Elmbank Crescent, Glasgow, C2. "Humps and Hollows in Curves of Resistance," A. M. Robb. 6.30 p.m.

Royal Institution of Great Britain

To-day, Dec. 15th.—21, Albemarle Street, W.1. "Infra-Red Spectra," W. H. J. Childs and H. A. Jahn. 2.30 p.m. "Transmission of Radio Waves through the Atmosphere," E. V. Appleton. 5.15 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS

MR. L. N. BURT, M.I. Mech. E., M. Cons. E., 20, Essex Street, W.C.2., informs us that owing to the war, he has removed his offices to 84, Harrow View, Harrow, Middlesex. Telephone, Harrow 0235.

MR. A. STUART ALLEN has joined the board of Siemens-Schuckert (Great Britain) Ltd., Brentford. Mr. Allen is the senior partner of Allen Baldry Holman and Best, Incorporated Accountants, of 36, New Broad Street, E.C.2.

MR. JOSEPH WALTON, a Director of Thos. W. Ward, Ltd., has been appointed an Assistant Managing Director of the Company. For many years he has been associated with the Rail and Siding Construction Department, and has been responsible for laying of important sidings in all parts of the country for Government factories and public works contractors. He is the Managing Director of The Darlington Railway Plant and Foundry Company, Ltd.

CONTRACTS AND ORDERS

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers

AILSA CRAIG LTD., of Chiswick, has received from Belgium an order for two Ailsa Craig marine Diesel engines of 20–30 H.P. with clutch and reverse gear in one unit.